Halliburton NUS
CORPORATION

2075 West Park Place, Suite E
Stone Mountain, GA 30087

(404) 413-0965
FAX: (404) 413-6733

C-92-3-3-30

July 6, 1993

8/31/93
ESI

Mr. Narindar Kumar
Site Investigation and Support Branch
Waste Management Division
Environmental Protection Agency
345 Courtland Street, N.E.
Atlanta, Georgia 30365

Subject: Site Inspection Prioritization Report
Georgia Power Company, Wansley Steam Plant
Roopville, Heard County, Georgia
EPA ID No. GAD000612937

Dear Mr. Kumar:

Halliburton NUS was tasked by B & V Waste Science and Technology Corporation under U.S. EPA Contract No. 68-W9-0055 to conduct a Site Inspection Prioritization (SIP) for Georgia Power Company, Wansley Steam Plant in Roopville, Heard County, Georgia. This study was performed under the authorization of the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA) and the Superfund Amendments Reauthorization Act of 1986 (SARA).

The Georgia Power, Wansley Steam Plant is located in a rural, wooded area east of Highway 27 off of Friendship Road along the Carroll County and Heard County line. The geographical coordinates for the facility are 33° 24' 48" N latitude and 85° 01' 56" W longitude (Ref. 1). A site location map is shown in Figure 1. The climate in the area is characterized by long and moderately hot summers and short, mild winters (Ref. 2, p. 1). The average annual precipitation is approximately 50 inches, and the net annual rainfall is 8 inches (Ref. 3, pp. 43, 63). The 2-year, 24-hour rainfall is approximately 4 inches (Ref. 4, p. 95).

The Georgia Power, Wansley Steam Plant site is an active coal-fired electric generating plant which is approximately 5,225 acres in size (Refs. 5; 6, p. 5). The majority of the site lies in Heard County, although portions are located in Carroll County (Ref. 1). A site layout map is shown in Figure 2. The facility is owned jointly by Georgia Power Company, Oglethorpe Power Corporation, the Municipal Electric Authority of Georgia, and the city of Dalton, Georgia. The plant is operated by Georgia Power Company and has been since its inception in 1976 (Ref. 5). The site, which is bounded by woods and the Chattahoochee River, consists of a power generating plant, a fly ash and a storage water pond, two construction landfills and an inert materials landfill, a coal runoff pond, and a retention pond. A facility recreation area is located on the north side of the water storage pond (Ref. 6, pp. 5-6).

10721235

U.S. EPA REGION IV

SDMS

POOR LEGIBILITY

PORTIONS OF THIS DOCUMENT MAY BE DIFFICULT TO VIEW DUE TO THE QUALITY OF THE ORIGINAL.

TO MAKE THE DOCUMENT READABLE, TRY ONE OR MORE OF THE FOLLOWING:

From the Displays Settings in Windows Control Panel:

1. Set the Color Quality to the highest available: 24 bit or 36 bit.
2. Increase or decrease the Screen resolution.

From the Monitor/Display Controls:

1. For dark image page, increase the brightness and decrease the contrast.
2. For light image page, decrease the brightness and increase the contrast.

**** PLEASE CONTACT THE APPROPRIATE RECORDS CENTER TO VIEW THE MATERIAL****

V. 2-040506

Plant operations include generating electricity by boiling water in large tanks (boilers) to generate steam which turns turbines. Coal and oil are used as fuel to heat the water (Ref. 7, p. 1). Wastes generated at the plant include fly ash from burning coal, washings from boiler cleanings, and waste solvents generated from routine maintenance activities (Refs. 7, p. 1; 8, pp. 4-5). The facility at one time also utilized PCB transformers but were reportedly changed out with non-PCB-type transformers and the former shipped to an authorized disposal facility (Ref. 8, p 3). Waste fly ash and boiler cleaner waste, which are not considered hazardous (as per 40 CFR 261.4(b) No. 4), are piped to a large unlined lake on site known as the Ash Pond. Waste solvents generated at the site are drummed and shipped by licensed waste management companies for disposal or reclamation (Ref. 6, p. 7). Records prior to 1980 concerning waste handling practices were not maintained (Ref. 7, p. 1).

On November 18, 1980, the facility filed a RCRA Part A application as a TSD facility. On August 15, 1983, its interim status was withdrawn, and the facility was, and is still, classified as a generator (Refs. 5, 9, 10). The facility also maintains a state of Georgia NPDES permit to regulate the release of water in the retention pond to the Chattahoochee River (Ref. 6, p. 5). A Preliminary Assessment was conducted by the Georgia Department of Natural Resources on August 21, 1985 (Ref. 7). A subsequent sampling investigation was conducted by EPA FIT 4 during September 1990, during which 33 environmental samples were collected. These samples included two surface soil, six subsurface soil, four groundwater, 10 surface water, and 11 sediment samples. The analytical results from this investigation revealed the presence of several metal and two organic compounds from seven different source areas. These compounds include, but are not limited to, arsenic, manganese, endosulfan, chromium, and thallium (Ref. 6).

The facility is located in the Northern Piedmont physiographic province (Ref. 11, pp. 3, 9). Underlying the facility are up to 150 feet of surficial deposits of residual soil and weathered rock which overlie fractured biotite gneiss bedrock of the Sandy Springs Group (Refs. 11, pp. 23, 24, 37, Plates I, Ib; 12, pp. 8-9). The aquifer of concern is the unconfined residual soil/crystalline rock aquifer system (Ref. 13, pp. 12, 13). Groundwater is contained within the pore spaces of the surficial deposits and in the joints, fractures, and other secondary openings in the bedrock (Ref. 14, p. 7). Hydraulic conductivity values for the surficial deposits are estimated to range from 1×10^{-5} to 1×10^{-7} cm/sec (Ref. 15, p. 29). The depth to groundwater is highly dependent upon topography and soil thickness and ranges from 4 to over 20 feet below land surface (bls) under the facility (Refs. 14, p. 10; 16, pp. 8, 14). The direction of groundwater flow is generally toward streams and rivers, perpendicular to topographic contour lines (Ref. 12, p. 9).

Analytical results of groundwater samples indicate the presence of several metal compounds at elevated levels. These included barium, beryllium, chromium, cobalt, copper, lead, magnesium, manganese, nickel, vanadium, and zinc (Ref. 6, p. 29). Three of these samples were collected from temporary monitoring wells installed at strategic locations on site at depths ranging from 4 to 14 feet bls. The background sample was collected from an upgradient onsite well at 45 feet bls (Ref. 6, p. 15). There are approximately 1,553 individuals within 4 miles of the site who rely on private wells for drinking water. The nearest private well is approximately 0.5 mile south of the site (Ref. 1). The breakdown of individuals per radius is as follows (based on a topographic house count and a multiplier of 2.75 persons per household): 0 to 0.25 mile - 0; 0.25 to 0.5 mile - 14 houses x 2.75, 39 persons; 0.5 - 1.0 mile - 23 houses x 2.75, 63 persons; 1.0 to 2.0 miles - 110 houses x 2.75, 302 persons; 2.0 to 3.0 miles - 198 houses x 2.75, 544 persons; 3.0 - 4.0 miles - 220 houses x 2.75, 605 persons (Refs. 1, 17).

Mr. Narindar Kumar
Environmental Protection Agency
C-92-3-3-30
July 6, 1993 - page three

The Georgia Power Wansley Plant has three primary drainage pathways. One, which originates at the Ash Pond, exits the pond at its southern side and flows south along a concrete-lined ditch to the retention pond southwest of the plant. The retention pond, which also receives cooling water discharge from the plant, is drained by an unlined ditch 1,000 feet in length which empties into the Chattahoochee River (Ref. 6, p. 9). Another drainage pathway originates at the storage water pond. This pond is fed by Yellow Dirt Creek, which flows into its northwest corner, and is drained by Yellow Dirt Creek at the eastern end of the pond. From this point, Yellow Dirt Creek flows southward 1.7 miles before reaching the Chattahoochee River. The southwest corner of the site represents the final primary drainage pathway. This area is drained by a small, unnamed tributary of the Chattahoochee River. This tributary flows southward between the large construction landfill and the inert landfill before reaching the Chattahoochee River approximately 2 miles away. The Chattahoochee River flows southward to complete the 15-mile migratory pathway (Refs. 1; 6, p. 9). There are no federally designated endangered or threatened species identified along the surface water migratory pathway, although the Chattahoochee River is used for recreational fishing (Refs. 18, 19, 20). The nearest drinking water intake is located 30 miles downstream from the site and is owned and operated by the city of LaGrange Water Department (Refs. 19, 20). The flowrate for the Chattahoochee River is 3,843 cubic feet per second (cfs) (Ref. 21, p. 147).

The site inspection conducted by EPA-FIT 4 revealed the presence of arsenic at elevated levels from a surface soil sample collected near the Ash Pond. Elevated levels of the pesticides delta-BHC and endosulfan sulfate were detected in downgradient sediment samples near the coal run-off pond. Eight metals were detected at elevated levels in at least three of six surface water samples collected from the confluence of the NPDES stream, the retention pond, and the coal pile runoff pond. These metals included aluminum, barium, calcium, iron, manganese, potassium, sodium, and vanadium. At the retention pond and at the coal-pile runoff pond, the maximum contamination levels for selenium and nickel were exceeded or equaled in respective samples collected from these areas (Ref. 6, pp. 32-33).

There are currently 325 employees at the Georgia Power, Wansley Steam Plant (Ref. 5). There are no schools, day-care centers, or terrestrial sensitive environments within 200 feet of the site. Sample GP-SS-02, collected from an ash pile at the easternmost portion of the site revealed the presence of arsenic (estimated 20 mg/kg) and thallium (2.1 mg/kg). Both of these compounds were detected above the Sample Quantitation Limit (SQL). This was the only area with known surface contamination (Refs. 1; 6, p. 32).

There are no analytical results available to determine if a release of contaminants to the air has occurred, although stacks from the power plant emit smoke on a regular basis. It is possible that debris from the ash pile may also become airborne. There are approximately 3,505 people living within a 4-mile radius of the site. (0 to 0.25 mile - 0; 0.25 to 0.5 mile - 39; 0.5 to 1.0 mile - 187 (68 x 2.75); 1 to 2 miles - 385 (140 x 2.75); 2 to 3 miles - 679 (247 x 2.75); 3 to 4 miles - 2,215 (Refs. 1, 17, 22). There are no sensitive environments within the study area, although the range of several federally-designated endangered species, including the Florida panther (Felis concolor coryi), the bald eagle (Haliaeetus leucocephalus), the Bachman's warbler (Vermivora bachmanii), and the red-cockaded woodpecker (Picoides dendrocopos borealis) include the state of Georgia (Ref. 18). In addition, the black-spored quillwart (Isoetes melanospora) is found in Heard County (Ref. 23).

Mr. Narindar Kumar
Environmental Protection Agency
C-92-3-3-30
July 6, 1993 - page four

Georgia Power, Wansley Steam Plant was evaluated to assess the threat posed to human health and the environment and to determine the need for additional investigation. The analytical results revealed the presence of several metals at significant levels in groundwater, surface water, and soil samples. In addition, pesticides and some organic constituents were also detected in surface water and subsurface soil samples at elevated levels. Coal ash consists primarily of silicon, aluminum, iron, and calcium. Secondary components include magnesium, potassium, sodium, and titanium. Eastern and midwestern coals are also characteristic of high proportions of arsenic, selenium, chromium, and vanadium (Ref. 24). The aforementioned metals were among those detected in samples collected in and around the Wansley Steam Plant site. Based on this and the threat to the groundwater and surface water pathways, further action is recommended for Georgia Power, Wansley Steam Plant.

Very truly yours,

Wendy A. Floyd for
Steven Petrides
HNUS Site Manager

Jancie S. Hatcher
BVWST Technical Reviewer

Hubert Wieland
BVWST Project Manager

SP/gwb

cc: Phil Blackwell
File 2T38, 6.2

References

1. U.S. Geological Survey, 7.5 minute series Topographic Quadrangle Maps of Georgia: Lowell (Photorevised 1982), Roopville (PR 1982), Frolona (PR 1982), Franklin (1964), Newnan SW (PR 1982), Whitesburg (PR 1982), scale 1:24,000.

2. U.S. Department of Agriculture, Soil Survey, Carroll and Haralson Counties, Georgia (University of Georgia, College of Agriculture, Agricultural Experiment Stations March 1971).

3. U.S. Department of Commerce, Climatic Atlas of the United States (Washington, D.C.: GPO, June 1968) Reprint 1983, National Oceanic and Atmospheric Administration, pp. 43, 63.

4. U.S. Department of Commerce, Rainfall Frequency Atlas of the United States, Technical Paper No. 40 (Washington, D.C.: GPO, 1961), p. 93.

5. Don Holder, Georgia Power Company, telephone conversation with Steve Petrides, Halliburton NUS Corporation, February 26, 1993. Subject: Information update for Georgia Power, Wansley Steam Plant.

6. Site Inspection Report for Georgia Power, Wansley Steam Plant, TDD No. F4-8909-62. Filed by John Jenkins, HALLIBURTON NUS Environmental Corporation, October 17, 1991.

7. Potential Hazardous Waste Site Preliminary Assessment (EPA Form 2070-12) and attachments for Georgia Power Company Wansley Steam Electric Generating Station. Filed by Steve Walker, Georgia Department of Natural Resources, August 21, 1985.

8. HALLIBURTON NUS Environmental Corporation Field Logbook No. F4-2500 for Georgia Power Plant Wansley, TDD No. F4-8909-62. Documentation of onsite facility reconnaissance, August 23, 1990.

9. EPA Hazardous Waste Permit Application (EPA Form 3510-1) for Georgia Power Wansley Steam Electric Generation Station, Roopville, Heard County, Georgia. Filed by W.E. Ehrensperger, Sr. V.P., Power Supply, November 18, 1980.

10. John D. Taylor, Program Manager, Georgia Department of Natural Resources Industrial & Hazardous Waste Management Program, letter to D.N. MacLemore, V.P. and Chief Engineer, Georgia Power Supply Engineering and Services, August 15, 1983. Subject: Withdrawal of application for a hazardous waste facility permit.

11. Keith McConnell and Charlotte Abrams, Geology of the Greater Atlanta Region, Bulletin 96 (Georgia Department of Natural Resources, Environmental Protection Division, Georgia Geologic Survey, 1984).

12. H.E. LeGrand, Ground Water of the Piedmont and Blue Ridge Provinces in the Southeastern States, Circular 538 (Washington, D.C.: GPO, 1967).

13. C.N. Joiner, M.S. Reynolds, W.L. Stayton, and F.G. Boucher, Ground-Water Data for Georgia, 1987, Open-File Report 88-323 (U.S. Geological Survey, 1988).

14. C.W. Cressler, C.J. Thurmond, and W.G. Hester, Groundwater in the Greater Atlanta Region, Georgia, Circular 63 (Georgia Department of Natural Resources, Environmental Protection Division, 1983).

15. Cherry, John A. and Freeze, R. Allen, Groundwater (Englewood Cliffs, N.J.: Prentice Hall, 1979).

16. HALLIBURTON NUS Environmental Corporation Field Logbook No: F4-2959 for Georgia Power Plant Wansley, TDD No. F4-8909-62. Documentation of field activities, September 17-20, 1990.

17. U.S. Department of Commerce, Proof Copy of table generated for 1990, CPH-1: Summary Population and House Characteristics, issued by Bureau of Census (April 1991).

18. U.S. Fish and Wildlife Service Endangered and Threatened Species of the Southeastern United States (Atlanta, Georgia, 1988).

19. Tammy Barr, City of Franklin Water Department, telephone conversation with John Jenkins, HALLIBURTON NUS Environmental Corporation, September 9, 1991. Subject: Fishing and boating along the Chattahoochee River south of Atlanta and water intakes on the Chattahoochee.

20. Walt Williams, Superintendent, City of LaGrange Water Department, telephone conversation with John Jenkins, HALLIBURTON NUS Environmental Corporation, September 16, 1991. Subject: Water intakes and recreational use of the Chattahoochee River.

21. Ernest J. Inman, Flow Characteristics of Georgia Streams (U.S. Geological Survey, 1971).

22. U.S. Environmental Protection Agency, Graphical Exposure Modeling Systems (GEMS) Data Base. Compiled from U.S. Bureau of the Census data (1980).

23. Georgia Department of Natural Resources, Freshwater Wetlands and Heritage Inventory Database for Heard County, July 1990.

24. "Wastes from the Combustion of Coal by Electric Utility Power Plants", Report to Congress, USEPA/530-SW-88-0022 (Washington, D.C.: Office of Solid Waste, February 1988).

U.S. EPA REGION IV

SDMS

Unscannable Material Target Sheet

DocID: 10721235 Site ID: GAD000612937

Site Name: Ga Power Co. Wansley

Nature of Material:

Map:	☑	Computer Disks:	☐
Photos:	☐	CD-ROM:	☐
Blueprints:	☐	Oversized Report:	☐
Slides:	☐	Log Book:	☐

Other (describe): U.S. Geological Survey 7.5 minute Series Topographic Quadrangle map of Ga.

Amount of material:

* Please contact the appropriate Records Center to view the material *

REFERENCE 2

SOIL SURVEY
Carroll and Haralson Counties Georgia

UNITED STATES DEPARTMENT OF AGRICULTURE
Soil Conservation Service
In cooperation with
UNIVERSITY OF GEORGIA, COLLEGE OF AGRICULTURE
AGRICULTURAL EXPERIMENT STATIONS

Issued March 1971

Contents

Issued March 1971

SOIL SURVEY OF CARROLL AND HARALSON COUNTIES, GEORGIA

REPORT BY J. F. BROOKS, SOIL CONSERVATION SERVICE

SOILS SURVEYED BY J. F. BROOKS, T. N. CRABB, AND R. D. WELLS, SOIL CONSERVATION SERVICE

UNITED STATES DEPARTMENT OF AGRICULTURE IN COOPERATION WITH THE UNIVERSITY OF GEORGIA, COLLEGE OF AGRICULTURE, AGRICULTURAL EXPERIMENT STATIONS

CARROLL AND HARALSON COUNTIES are in the northern half of Georgia on the western boundary of the State (fig. 1). The Chattahoochee River flows along the southeastern boundary. Douglas and Paulding Counties join these counties on the east and separate the two counties from the metropolitan area of Atlanta.

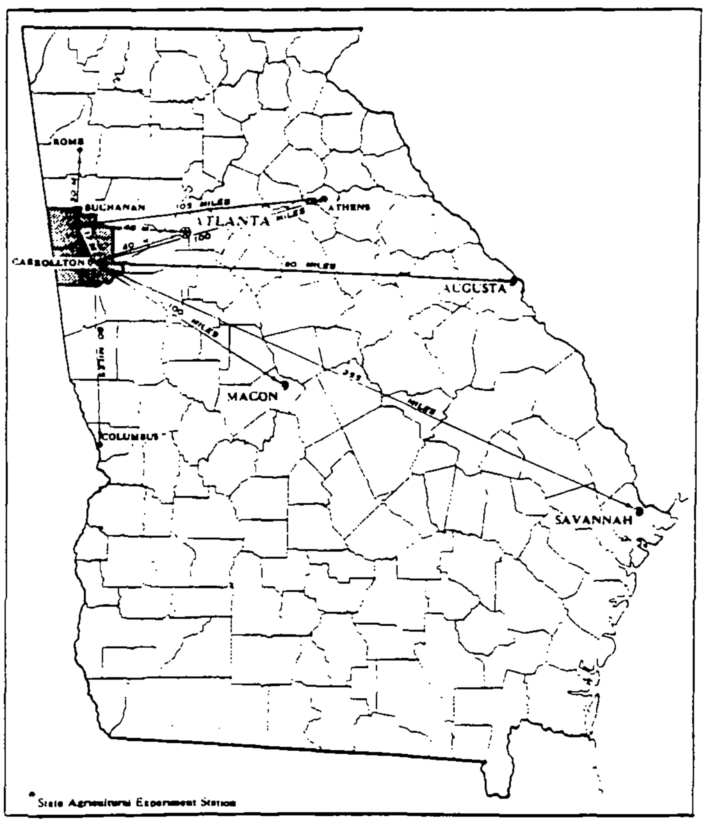


Figure 1.—Location of Carroll and Haralson Counties in Georgia.

The total area of Carroll and Haralson counties is 780 square miles, or 499,200 acres. The dominantly loamy soils in these counties are mainly rolling, but in places are hilly.

Most of the income from farming is from the sale of poultry, livestock, and livestock products. Corn, cotton, pimento peppers, and vegetables are grown for sale on a number of farms.

The population of the two counties was 48,775 in 1950 and 50,994 in 1960. About 60 percent of the people live in the rural areas. Carrollton is the largest town and county seat of Carroll County, and Buchanan is the county seat of Haralson County.

The climate of the area is characterized by long, moderately hot summers and short, mild winters. In summer, daytime temperatures between 85° and 90° F. are common, but the nights are moderately cool. Occasionally the temperature drops to around 15° in winter, but only for short periods. Precipitation averages about 51 inches per year.

How This Survey Was Made

Soil scientists made this survey to learn what kinds of soils are in Carroll and Haralson Counties, where they are located, and how they can be used.

The soil scientists went into the survey area knowing they likely would find many soils they had already seen and perhaps some they had not. As they traveled over the two counties, they observed steepness, length, and shape of slopes; size and speed of streams; kinds of native plants or crops; kinds of rock; and many facts about the soils. They dug or bored many holes to expose soil profiles. A profile is the sequence of natural layers, or horizons, in a soil; it extends from the surface down into parent material that has not been changed much by leaching or by the action of plant roots.

The soil scientists made comparisons among the profiles they studied, and they compared these profiles with those in counties nearby and in places more distant. They classified and named the soils according to uniform procedures.

The soil series and the soil phase are the categories most used in a local survey.

Soils that have profiles almost alike make up a soil series. Except for different texture in the surface layer, all the soils of one series have major horizons that are similar in thickness, arrangement, and other important characteristics. Each soil series is named for a town or other geographic feature near the place where that soil was first observed and mapped. Madison and Grover, for example, are the names of two soil series. All the soils in the United States having the same series are essentially alike in natural characteristics.

Soils of one series can differ somewhat in texture of the surface layer and in slope, stoniness, or some other characteristic that affects use of soils by man. On the basis of such differences, a soil series is divided into phases. For example, Madison gravelly fine sandy loam, 2 to 6 percent slopes, eroded, is one of several phases within the Madison series.

After a guide for classifying and naming the soils had been worked out, the soil scientists drew boundaries of the individual soils on aerial photographs. These photographs show woodlands, buildings, field borders, trees, and other details that greatly help in drawing soil boundaries accurately. The soil map in the back of this survey was prepared from aerial photographs.

The areas shown on a soil map are called *mapping units*. On most maps detailed enough to be useful in planning management of farms and fields, a mapping unit is nearly equivalent to a soil phase. It is not exactly equivalent, because it is not practical to show on such a map all the small, scattered bits of soil of some other kind that have been seen within an area that is dominantly of a recognized soil phase.

Some mapping units are made up of soils in a series that have different textures in their surface layer. In Carroll and Haralson Counties, Congaree soils are a mapping unit of this kind that is called an undifferentiated group. In this group each of the Congaree soils having a different texture could be mapped individually, but all of them are mapped as one unit because, for the purpose of the survey, there is no value in separating them. The pattern and proportion of the soils are not uniform. Another undifferentiated group in the survey is Chewacla soils, frequently flooded.

In most places surveyed there are areas where the soil material is so rocky, so shallow, or so severely eroded that it cannot be classified by soil series. These areas are shown on the soil map and are described in the survey, but they are called land types and are given descriptive names. Gullied land is the only land type mapped in Carroll and Haralson Counties.

While a soil survey is in progress, samples of soils are taken, as needed, for laboratory measurements and for engineering tests. Data on yields of crops under defined practices are assembled from farm records and from field or plot experiments on the same kind of soils. Yields under defined management are estimated for all the soils.

But only part of a soil survey is done when the soils have been named, described, and delineated on the map, and the laboratory data and yield data have been assembled. The mass of detailed information then needs to be organized in a way that it is readily useful to different groups of readers, among them farmers, managers of woodlands, engineers, and homeowners.

On the basis of yield and practice tables and other data, the soil scientists set up trial groups. They test these groups by further study and by consultation with farmers, agronomists, engineers, and others, and they then adjust the groups according to the results of their studies and consultation. Thus, the groups that are finally evolved reflect up-to-date knowledge of the soils and their behavior under present methods of use and management.

General Soil Map

The general soil map at the back of this survey shows, in color, the soil associations in Carroll and Haralson Counties. A soil association is a landscape that has a distinctive proportional pattern of soils. It normally consists of one or more major soils and at least one minor soil, and it is named for the major soils. The soils in one association may occur in another, but in a different pattern.

A map showing soil associations is useful to people who want a general idea of the soils in an area, who want to compare different parts of an area, or who want to know the location of large tracts that are suitable for a certain kind of farming or other land use. Such a map is not suitable for planning the management of a farm or field, or for choosing the site for a building or other structure, because the soils in any one association ordinarily differ in slope, depth, stoniness, drainage, and other characteristics that affect management.

Soil associations and delineations on the general soil map in this soil survey do not fully agree with those of the general soil maps in adjacent counties published at a different date. Differences in the maps are the result of improvements in the classification of soils, particularly in the modifications or refinements in soil series concepts. In addition, more precise and detailed maps are needed because the uses of the general soil maps have expanded in recent years. The more modern maps meet this need. Still another difference is caused by the range in slope that is permitted within associations in different surveys.

Of the 11 soil associations in Carroll and Haralson Counties, two consist of nearly level soils on bottom lands and low stream terraces; five consist of gently sloping and moderately sloping soils of uplands; and four consist of strongly sloping and steep soils of uplands. These associations are described in the following pages.

Nearly Level Soils on Bottom Lands and Low Stream Terraces

The soils on the bottom lands are loamy or sandy and generally are mottled with brown and gray. They are nearly level and lie along the Little Tallapoosa and Tallapoosa Rivers and along major creeks. Soils of the low terraces are mostly loamy or clayey and mottled with olive gray, yellowish brown, or gray. They are chiefly along the outer edges of the major alluvial plains. Two associations in Carroll and Haralson Counties are on bottom lands and low terraces.

1. Chewacla-Augusta association

Somewhat poorly drained, nearly level soils on frequently flooded bottom lands and on low stream terraces

This association is characterized by nearly level soils on broad to narrow bottom lands along streams and around heads of drainageways. Stream channels are shallow, for they are partly filled with sediment and debris. They meander in many places and overflow frequently. This association occupies about 8 percent of the two counties.

The Chewacla soils make up about 80 percent of this association: the Augusta soils, about 8 percent; and minor soils, the remaining 12 percent.

Chewacla soils occupy the first bottoms along streams. These soils have a dark-brown silt loam surface layer about 8 inches thick. The subsoil extends to a depth of about 46 inches or more and consists of light olive-brown silt loam underlain by olive-gray sandy clay loam. The subsoil is mottled in the upper part and is gleyed in the lower part. Chewacla soils formed in recent alluvium deposited by the frequent floods.

Augusta soils occur on low stream terraces in and around the heads of drainageways. These soils have a dark grayish-brown loam surface layer about 9 inches thick. The subsoil extends to a depth of about 72 inches and is pale-olive, light olive-gray, and yellowish-brown sandy clay loam in the upper part and mainly light-gray and yellowish-brown clay loam in the lower part. The subsoil is mottled throughout. Augusta soils formed in old alluvium.

Minor soils in this association are the Worsham, Congaree, Buncombe, and Masada. The Worsham soils are on stream terraces and are poorly drained. Masada soils occupy higher stream terraces and are well drained to moderately well drained. The well drained Congaree and excessively drained Buncombe soils are on first bottoms.

This association is widely distributed throughout the counties and is a part of most farms. Most of the acreage has been cleared and is cultivated or pastured. The major soils are suited to many locally grown crops, such as corn, grain sorghum, fescue, dallisgrass, and white clover. In many places excavation of stream channels and ditching to improve drainage are required before cultivated crops can be grown. Except in the wetter spots, tilth is generally good.

Because of the flooding hazard, the major soils in this association have severe limitations if used for homesites, intensive play areas, sites for light industries, and trafficways. Oxidation ponds can be built only in areas that are near the base of upland slopes and are not severely flooded, and even in these areas there is a moderate limitation because of the moderate permeability of the dominant soils.

2. Congaree-Buncombe association

Well-drained to excessively drained, nearly level soils on infrequently flooded bottom lands

This association consists of nearly level soils on broad to narrow bottom lands and around the heads of drainageways. The streams seldom overflow, and their channels have little sediment or debris. This association occupies about 2 percent of the two counties.

The Congaree soils make up about 85 percent of this association: the Buncombe soils, about 10 percent; and minor soils, the remaining 5 percent.

Congaree soils are well drained. They are on first bottoms and around the heads of drainageways. These soils have a reddish-brown fine sandy loam surface layer about 16 inches thick. It is underlain by dark-brown sandy loam that is over reddish-brown fine sandy loam. In some places gray mottles occur below a depth of 30 inches. Congaree soils formed in recent alluvium along streams and drainageways.

Buncombe soils are on first bottoms and are excessively drained. These soils have a dark yellowish-brown loamy sand surface layer about 13 inches thick. It is underlain by layers of loamy sand that are yellowish brown, dark brown, and dark yellowish brown. Buncombe soils formed in recent sandy alluvium.

Minor soils in this association are the Chewacla. These soils are in fairly large areas along streams and drainageways. Chewacla soils are somewhat poorly drained and frequently flooded.

This association is widely distributed throughout the two counties and is a small part of many farms. Most of the acreage has been cleared and is cultivated or pastured. The soils are suited to many locally grown crops, such as corn (fig. 2), grain sorghum, bermudagrass, tall fescue, dallisgrass, and white clover. An abundant source of irrigation water is available in nearby streams. Tilth is good, and except during the wetter periods, the soils can be worked easily.

Figure 2.—**Planting corn on the Congaree-Buncombe soil association.**

Because of the flood hazard, the major soils in this association have severe limitations if used for homesites, campsites, intensive play areas, sites for light industries, and trafficways.

Gently Sloping and Moderately Sloping Soils of the Uplands

In five soil associations the soils are gently sloping and moderately sloping and occur chiefly on ridgetops and interstream divides. Slopes generally range from 1 to 10 percent. These soils are dominantly yellowish brown to

...nfarm uses and the chief limiting properties—Continued

Recreation—Continued			Light industries	Trafficways
Picnic areas	Intensive play areas	Golf fairways		
Moderate: 10 to 25 percent slopes.	Severe: 10 to 25 percent slopes.	Moderate to severe: 10 to 25 percent slopes.	Severe: 10 to 25 percent slopes.	Moderate: 10 to 25 percent slopes.
Slight	Severe: 6 to 10 percent slopes.	Moderate: 6 to 10 percent slopes.	Moderate: shallow to soft rock.	Moderate: fair traffic-supporting capacity; shallow to soft rock.
Moderate: 10 to 15 percent slopes.	Severe: 10 to 15 percent slopes.	Moderate: 10 to 15 percent slopes.	Severe: shallow to soft rock; 10 to 15 percent slopes.	Moderate: fair traffic-supporting capacity; shallow to soft rock.
Moderate: 15 to 25 percent slopes.	Severe: 15 to 25 percent slopes.	Severe: 15 to 25 percent slopes.	Severe: shallow to soft rock; 15 to 25 percent slopes.	Moderate: fair traffic-supporting capacity; shallow to soft rock.
Moderate: coarse fragments.	Severe: 2 to 5 feet to hard rock; coarse fragments.	Severe: 2 to 5 feet to hard rock.	Severe: 2 to 5 feet to hard rock.	Severe: 2 to 5 feet to hard rock.
Severe: seasonal high water table; flood hazard.	Severe: seasonal high water table; flood hazard.	Severe: seasonal high water table; flood harzard.	Severe: flood hazard	Severe: flood hazard; poor traffic-supporting capacity.

ual material; that is, material weathered from the underlying rock.

According to a geologic map of Georgia (2), about 85 percent of the two counties is underlain by biotite gneiss and schist, phyllite, Ashland mica schist, and Wedowee schist. The main residual soils that were derived from these rocks are in the Madison, Grover, Louisa, Tallapoosa, and Hulett series. Most of these soils are highly micaceous.

The remaining 15 percent of the two counties is underlain by Augen gneiss, granite gneiss, and hornblende gneiss. The principal soils that were derived from these rocks are the Davidson and Musella. The clay in these soils is kaolinitic.

Soils that formed in alluvium occupy 12 percent of the two counties. These soils are mainly along larger streams. In about 3 percent of the survey area the soils formed in old alluvium, and in the remaining 9 percent they formed in recent alluvium. Much of the alluvium originated from rocks in the nearby uplands, but some of it was derived from the granitic and metamorphic rocks of the mountains to the northeast.

The soils on the flood plains are forming in recent alluvium and show little profile development. They are still receiving deposits. The principal soils that are forming in recent alluvium are the Buncombe, Congaree, and Chewacla.

The soils of the stream terraces formed in old alluvium and have distinct horizons. Some of the stream terraces are in the flood plain, but others are as high as 50 feet above the flood plain. The principal soils that formed in old alluvium are the Masada, Augusta, and Worsham.

Relief

Relief, or shape of the landscape, affects soil formation through its influence on drainage, erosion, plant cover, and soil temperature. In this area relief is largely determined by the kind of bedrock underlying the soils, by the geology of the area, and by the dissection by streams. The relief in these two counties is gently rolling to hilly and includes narrow stream valleys.

The soils of the survey area have slopes of 0 to 40 percent. Soils of the uplands that have slopes of less than 15 percent are generally thicker and have more distinct horizons than more strongly sloping soils. From soils that have slopes of 15 to 40 percent, geologic erosion removes soil material almost as fast as it is weathered. As a result, most strongly sloping to steep soils have a thin root zone. Louisa, Louisburg, Wilkes, and Musella soils are of this kind.

The uplands range from 1,000 to 1,600 feet above sea level, and the bottom lands range from 700 to 1,000 feet. Partly because of this range in elevation and the many branching drainageways, drainage is good in most upland areas. Excess water moves into the drainage channels rapidly and is removed quickly.

Climate

Climate, as a factor of soil formation, affects the physical, chemical, and biological relationships in the soil profile, primarily through the influence of precipitation and temperature.

Temperature and rainfall have much to do with the rates that rocks weather and minerals decompose. They also influence leaching and transporting of minerals and organic matter through the soil profile. The amount of water that percolates through the soil at a given point depends on rainfall, relative humidity, length of the frost-free period, soil permeability, and physiographic position. Climate, therefore, directly affects the accumulation of parent material and the differentiation of horizons. The effects of climate indirectly control the kinds of plants and animals that can thrive in a region.

The climate of Carroll and Haralson Counties is of the humid, warm-temperature, continental type that is characteristic of the southeastern part of the United States. In this type of climate, the soils are moist much of the time from December 1 through August 31. They are moderately dry much of the time from September 1 through November 30. The surface layer is frozen only a few days each year, and then only to a depth of 1 to 3 inches.

Because the climate is uniform throughout the two counties, it has not caused major local differences among the soils. It has tended to cause similarities, even among soils developed from different kinds of parent material. As expected in this type of climate, most of the soils in the area are highly weathered, leached, strongly acid, and low in natural fertility.

Plant and animal life

The kinds and number of plants and animals that live on and in the soil are, in large part, determined by the climate and, to varying degrees, by the parent material, relief, and time (age of the soil). Bacteria, fungi, and other micro-organisms aid in weathering rock and decomposing organic matter. They are important chiefly in horizon differentiation, and to a lesser degree in the accumulation of soil parent materials. Among the changes caused by living organisms are gains in organic matter and nitrogen in the soil, gains or losses in plant nutrients, and changes in structure and porosity.

The larger plants furnish organic matter. They also transfer elements from the subsoil to the surface soil by assimilating those elements into their tissue and then depositing this tissue on the soil surface as fallen fruit, leaves, and stems. When trees are uprooted, soil material is carried to the surface by the upturned roots. Earthworms and other small invertebrates carry on a slow but continual cycle of soil mixing. The fungi and other micro-organisms that live in the soil are most numerous in the upper few inches of the profile.

Before 1800, the uplands of the survey area were covered by forests. The forests consisted mainly of oak and hickory but included a few pines. The soils of the first bottoms were generally in yellow-poplar, gum, ash, oak, willow, and beech. Most of the area was cleared and cultivated at a later time, but much of it is now in pines.

Man is important to the future direction and rate of development of the soils because he clears the forests, cultivates the soils, and introduces new kinds of plants. Few results of these activities can yet be seen, except for a sharp reduction in the content of organic matter after a few months of cultivation and, in sloping, cultivated areas, a loss of the coarser textured surface because of accelerated erosion. Some results probably will not be evident for many centuries. Nevertheless, the complex of living organisms affecting soil formation in the survey area has been drastically changed as a result of man's activity.

Time

Generally a long time is required for a soil to form. The length of time that parent materials have been in place, therefore, is usually reflected in the character of the soil.

Where soil material has been in place for a long time, and has approached an equilibrium with its environment, the soil tends to have well-defined and related horizons. Examples of soils of this kind are the Madison, Grover, Hulett, and Davidson of the uplands and the Masada, Augusta, and Worsham of the stream terraces. On the flood plains, the soil material has not been in place long enough for a mature profile to develop. The Buncombe, Congaree, and Chewacla soils are of this kind.

Processes of Horizon Differentiation

Several processes affected the formation of soil horizons in the soils of Carroll and Haralson Counties. These processes are (1) accumulation of organic matter, (2) leaching of bases, (3) formation and translocation of silicate clay minerals, and (4) oxidation, or reduction, and transfer of iron. In most soils, more than one of these processes have been active in the development of horizons.

In most of the soils in these counties organic matter has accumulated in the upper part of the profile, and a thin A1 horizon has formed. This accumulation is greatest in undisturbed areas. After the soil is cleared and cultivated, the losses of organic matter are greater than the gains, and in most soils the organic-matter content reaches a low level.

Leaching of bases has occurred in nearly all of the soils in the survey area. Soil scientists have generally agreed that leaching of bases in soils keeps pace with their release in the breakdown of primary minerals of the rocks. Most of the soils are moderately to strongly leached, and this is reflected by the soils in the counties becoming acid. The Iredell and Wilkes soils formed in saprolite of diorites, diabase, chloritic schist, and the like, and are not so depleted of bases as are other soils in the two counties. Reaction in these soils is about neutral in the horizons below the surface horizon.

In most of the soils in the two counties, the translocation of clay minerals has contributed to horizon development. This is particularly true for the older soils of the uplands and stream terraces. The leached A2 horizons, which are above the B horizons, have a granular structure, contain more sand and less clay than the B horizons, and generally are grayish or brownish. In some places the B horizons have accumulations of clay, as indicated by coatings on the surfaces of blocky peds. These characteristics reflect losses of iron and clay and additions of organic matter. Where natural drainage is good, the red or reddish colors of the B horizons indicate the oxidation of iron to iron oxides.

Reduction and transfer of iron, a process called gleying, is evident in the more poorly drained soils of the survey area. The grayish color in the subsoil horizons indicates the reduction and loss of iron. In a few soils of this kind some of the horizons contain reddish-brown mottles and concretions, which indicate a segregation of iron.

To summarize the more important processes in horizon differentiation in the soils of this survey area are the leaching of bases, the translocation of silicate clay, and the oxidation or reduction of iron.

Classification of Soils

Classification consists of an orderly grouping of defined kinds of soils into classes in a system designed to make it easier to remember soils and their characteristics and interrelationships. Classification also helps to organize and apply results of experience and research to areas ranging from plots of several acres to tracts covering millions of square miles. The defined kinds of soils are placed in narrow classes for use in detailed soil surveys and for application of knowledge within farms and fields. The large number of narrow classes are then grouped in progressively fewer and broader classes in higher categories so that information can be applied to larger areas, such as countries and continents.

The current system of classifying soils was adapted for general use by the National Cooperative Soil Survey in 1965. This system is under continual study. Readers interested in developments of this system should search the latest literature available (*3, 6*).

Under the current system of classifying soils (*6*), all soils are placed in six categories. Beginning with the most inclusive, these categories are the order, the suborder, the great group, the subgroup, the family, and the series. The criteria used as a basis for classification in this system are observable or measurable properties. The properties are chosen so that soils of similar mode of origin are grouped together.

In table 7 the soil series of Carroll and Haralson Counties are placed in some of the classes of the current system. The classes in the current system are briefly defined in the following paragraphs.

ORDER: Ten soil orders are recognized in the current system. They are Entisols, Vertisols, Inceptisols, Aridisols, Mollisols, Spodosols, Alfisols, Ultisols, Oxisols, and Histosols. The properties used to differentiate the soil orders are those that tend to give broad climatic grouping of soils. Two exceptions are Entisols and Histosols, which occur in many different climates.

Table 7 shows that the four orders recognized in Carroll and Haralson Counties are the Entisols, Inceptisols, Alfisols, and Ultisols. Entisols are recent mineral soils that do not have genetic horizons or have only the beginning of such horizons.

Inceptisols are mineral soils in which genetic horizons have started to develop. Their name is derived from the Latin word *inceptum*, which means beginning.

Alfisols are minerals soils that have an illuvial horizon in which significant amounts of clay minerals have accumulated and in which base saturation is more than 35 percent at a depth of 50 inches below the top of the clay-enriched horizon.

Ultisols are mineral soils that have a clay-enriched B horizon with a base saturation of less than 35 percent at a depth of 50 inches below the top of the clay-enriched horizon. Mineral soils are also Ultisols if they have a fragipan in a clay-enriched horizon that has a base saturation of less than 35 percent at a depth of 30 inches below the top of the pan. Most of the soils in this survey area are Ultisols.

SUBORDER: Each order is subdivided into suborders, primarily on the basis of those soil characteristics that seem to produce classes with the greatest genetic similarity. The suborders narrow the broad climatic range permitted in the orders. The soil properties used to separate suborders are mainly those that reflect either the presence or absence of waterlogging, or soil differences resulting from the climate or vegetation. The names of suborders have two syllables. The last syllable indicates the order. An example is Udult (Ud, meaning of humid climates, and ult from Ultisol. Suborders are not given in table 7, because the last two syllables of the subgroup name the suborder.

GREAT GROUP. Soil suborders are separated into great groups according to the presence or absence of genetic horizons and the arrangement of these horizons. The horizons used to make separations are those in which clay, iron, or humus have accumulated or those that have pans that interfere with the growth of roots or the movement of water. The features used are the self-mulching properties of clay, soil temperature, major differences in chemical composition (mainly calcium, magnesium, sodium, and potassium), and the like. The names of great groups have three or four syllables and are made by adding a prefix to the name of the suborder. An example is Hapludult (Hapl, meaning simple; ud, for humid; and ult, from Ultisol). The great group is not shown separately in table 7, because it is the last word of the name of the subgroup.

SUBGROUP: Great groups are subdivided into subgroups, one representing the central (typic) segment of a group and others, called intergrades, that have properties of one great group and also one or more properties of another great group, suborder, or order. Subgroups

TABLE 7.—*Classification of soil series in Carroll and Haralson Counties, Ga., according to the current system of classification*[1]

Series	Family	Subgroup	Order
Augusta	Fine-loamy, mixed, thermic	Aeric Ochraquults	Ultisols.
Buncombe	Mixed, thermic	Typic Udipsamments	Entisols.
Chewacla	Fine-loamy, mixed, thermic	Aquic Fluventic Dystrochrepts	Inceptisols.
Congaree	Fine-loamy, mixed, nonacid, thermic	Typic Udifluvents	Entisols.
Davidson	Clayey, kaolinitic, thermic	Rhodic Paleudults	Ultisols.
Grover	Fine-loamy, micaceous, thermic	Typic Hapludults	Ultisols.
Hulett	Clayey, kaolinitic, thermic	Typic Hapludults	Ultisols.
Iredell	Fine, montmorillonitic, thermic	Vertic Hapludalfs	Alfisols.
Louisa	Loamy, micaceous, thermic, shallow	Ruptic Ultic Dystrochrepts	Inceptisols.
Louisburg	Coarse-loamy, mixed, thermic	Ruptic Ultic Dystrochrepts	Inceptisols.
Madison	Clayey, kaolinitic, thermic	Typic Hapludults	Ultisols.
Masada	Fine-loamy, mixed, thermic	Typic Hapludults	Ultisols.
Musella	Fine-loamy, mixed, thermic	Typic Rhodudults	Ultisols.
Tallapoosa	Loamy, micaceous, thermic, shallow	Ochreptic Hapludults	Ultisols.
Wilkes	Loamy, mixed, thermic, shallow	Typic Hapludalfs	Alfisols.
Worsham	Clayey, mixed, thermic	Typic Ochraquults	Ultisols.

[1] Placement of some series in the current system of classification, particularly in families, may change as more precise information becomes available.

may also be made in those instances where soil properties intergrade outside of the range of any other great group, suborder, or order. The names of subgroups are derived by placing one or more adjectives before the name of the great group. An example is Typic Hapludult (a typical Hapludult).

FAMILY. Families are separated within a subgroup primarily on the basis of properties important to the growth of plants or behavior of soils where used for engineering. Among the properties considered are texture, mineralogy, reaction, soil temperature, permeability, thickness of horizons, and consistence. A family name consists of a series of adjectives preceding the subgroup name. The adjectives are the class names for texture, mineralogy, and so on that are used to designate the family. An example is the clayey, kaolinitic, thermic family of some Typic Hapludults.

SERIES: The series is a group of soils that have major horizons that, except for texture of surface layer, are similar in important characteristics and in arrangement in the profile. Soil series are named for a geographic location near the place where that series was first observed and mapped.

General Nature of the Area

Discussed in this section for Carroll and Haralson Counties are organization and settlement, transportation and markets, industries, climate, geology, physiography, and drainage, water supply, and farming. The figures for population and the statistics on farming are from reports of the U.S. Bureau of the Census.

Organization and Settlement

Carroll County was organized in 1826 and originally consisted of all the land between the Chattahoochee River on the east, the Alabama State line on the west, and the Cherokee Indian Nation on the north. This land was obtained from the Creek Indians by the Treaty of 1825 at Indian Springs. Parts of the land have been cut off from Carroll County at different times to form Heard, Troup, Douglas, and Haralson Counties.

Haralson County was organized in 1856 from a part of Carroll County and land ceded to the U.S. Government by the Cherokee Indians.

Early settlers in this area arrived in the 1820's from the eastern part of Georgia and from Virginia and the Carolinas. Early farming consisted of growing corn, wheat, and barley and raising cattle, hogs, chickens, and sheep for home use or for trading.

The population of the two counties was 48,775 in 1950 and 50,994 in 1960. About 60 percent of the population is rural.

Carrollton, the largest town and the county seat of Carroll County, had a population of 10,973 in 1960. Buchanan, the county seat of Haralson County, had a population of 753 in 1960. Other towns in the survey area are Bowdon, Villa Rica, Roopville, Temple, Mount Zion, and Whitesburg in Carroll County and Bremen and Tallapoosa in Haralson County.

Transportation and Markets

U.S. Highway No. 78 runs from east to west through the area, and U.S. Highway No. 27 runs from north to south. State Routes 5, 16, 61, 100, 101, 113, 120, and 166 also serve the two counties. All of these highways and many of the county roads are paved. Most of the other roads are surfaced with sandy or gravelly materials and are used throughout the year. In the future, Interstate Highway No. 20 will roughly parallel U.S. Highway No. 78 between Atlanta and Birmingham, Ala.

Two main railroads serve these two counties. The main line of one of these railroads runs between Atlanta and Birmingham, Ala., and the other runs from Chattanooga, Tenn., to Macon and Columbus, Ga. Bus service is available to and from the towns of Carrollton, Villa Rica, Temple, Bremen, and Tallapoosa. Trucklines serve all the towns.

Markets for grain, cotton, hay, pulpwood, and lumber are available in the area. The State Farmers Market in Atlanta is an outlet for vegetables, melons, fruits, and other produce. Livestock auction barns are located in Carrollton, La Grange, Atlanta, and Rome. Carrollton has a poultry processing plant, 3 meat processing plants, and a plant processing dairy products.

Industries

Manufacturing is diversified among 70 plants in the survey area. Products manufactured or processed in the two counties include copper and aluminum wire and cable, men's clothing, hosiery, shoes, auto parts, stainless steel tubing, latex, chemicals, concrete products, frozen foods, meat, dairy, and poultry products, lumber, printed cloth, and other textile products.

In 1964 approximately 9,670 people were employed in industry. Textile, garment, and heavy metal plants employed the most workers. Many of the jobs are filled by part-time farmers and people who live in rural areas and commute daily.

The Climate of Carroll and Haralson Counties [5]

In Carroll and Haralson Counties the climate is influenced by the elevation of the survey area, the higher mountains to the north, and the Gulf of Mexico to the south. These factors moderate both summer and winter temperatures and cause ample precipitation that is usually well distributed throughout the year. Table 8 provides data on the temperatures and precipitation in these two counties. The probabilities of the last freezing temperatures in spring and the first in fall are given in table 9.

Elevation within the two counties roughly ranges from 700 to 1,600 feet above sea level, but the higher mountains in the northern part of Georgia are a partial barrier to the cold air that flows southward during winter. Because of this barrier, the cold air is usually considerably modified when it reaches the survey area. Freezing occurs early in the morning on slightly more than half of the days from mid-November to mid-March, but the temperature is as low as 20° F. only 10 to 15 times during an average win-

[5] Prepared by HORACE S. CARTER, State climatologist, U.S. Weather Bureau, Athens, Ga.

er. Temperatures below zero have been observed in the northern part of Haralson County but are very rare in the southern part of Carroll County. The hilly terrain often causes large differences in minimum temperatures within short distances. On clear, still nights, air cooled by radiation drains down the hills into valleys and other low areas and collects in pockets of cold air. The extreme minimum temperature in the valleys may be 10° to 15° lower than that on the surrounding slopes. Cold pockets of air are important in the selection of sites for certain crops and orchards and in scheduling spring planting.

The freeze-free growing period normally extends from early in April to late in October and averages slightly more than 200 days. The length of this period varies considerably between the northern part of Haralson County and the southern part of Carroll County. It also varies considerably according to local terrain and exposure.

In this survey area summer temperatures are more pleasant than those in lower areas to the south and east. Temperatures in the afternoon reach or exceed 90° on about half of the days in June, July, and August. A temperature of 100°, however, occurs in only about 1 year in 5. Because of elevation, temperatures are even more comfortable at night. Early in the morning the temperature is usually in the sixties throughout the summer. The average minimum temperature for the three months in summer is slightly higher than 65°.

Precipitation averages about 51 inches per year. Usually the wettest period is early in spring, and the driest is in fall. March is the only month that averages more than 6 inches, and only October averages less than 3 inches. Precipitation during the cool period is usually associated with large, low-pressure storm centers and weather fronts. Slow-moving air masses sometimes bring prolonged

TABLE 8.—*Temperature and precipitation data for Carroll and Haralson Counties, Ga.*

Month	Temperature				Precipitation		
			2 years in 10 will have at least 4 days with—			1 year in 10 will have—	
	Average daily maximum	Average daily minimum	Maximum temperature equal to or higher than—	Minimum temperature equal to or lower than—	Average monthly total	Less than—	More than—
	° F.	*° F.*	*° F.*	*° F.*	*Inches*	*Inches*	*Inches*
January	54.2	32.4	71	15	5.08	1.9	7.9
February	58.2	34.3	73	18	5.29	2.0	8.1
March	64.0	39.7	80	25	6.08	2.6	9.7
April	74.6	48.6	86	33	5.38	1.6	8.1
May	82.5	55.9	91	43	3.33	1.0	6.6
June	87.9	64.0	96	54	3.97	2.0	7.2
July	89.2	66.7	96	60	5.09	2.3	8.6
August	89.2	65.4	96	58	3.87	1.8	7.4
September	83.6	60.1	93	50	3.28	.8	6.5
October	75.0	48.7	86	31	2.20	.8	6.5
November	64.0	37.9	77	23	3.25	1.1	5.8
December	55.4	33.1	70	17	4.51	1.9	8.9
Year	73.0	48.9	98	12	51.34	41.9	62.8

TABLE 9.—*Probabilities of last freezing temperature in spring and first freezing temperature in fall*

Probability	Dates for given probability at temperatures of—		
	24° F.	28° F.	32° F.
Spring:			
1 year in 10 later than	March 27	April 10	April 20
2 years in 10 later than	March 22	March 30	April 14
5 years in 10 later than	March 8	March 23	April 8
Fall:			
1 year in 10 earlier than	November 1	October 25	October 18
2 years in 10 earlier than	November 9	October 30	October 22
5 years in 10 earlier than	November 18	November 4	October 30

periods of steady rainfall to the area. In contrast, most precipitation during the warm period comes in afternoon showers that usually do not last long. But these summer showers are sometimes intense and cause considerable erosion. Although the amount of rainfall is generally adequate for farming and other uses, dry spells of two or more weeks occur during most years. Fortunately, these spells are more frequent late in summer and in fall after most major crops have been harvested. Light snow falls during most winters but seldom accumulates on the ground.

Thunderstorms usually occur on about 50 days a year. They may occur during any month but are more frequent in spring and summer. Hail and damaging winds occur occasionally with some of the more severe storms.

The average monthly relative humidity ranges from 80 to 90 percent early in the morning and from 50 to 60 percent early in the afternoon. Humidity is usually higher late in summer and in fall and is lower in spring.

The prevailing wind is usually from north to northwest from fall to spring and is variable to southerly in summer. Average velocity ranges from about 11 miles per hour from January through March to slightly more than 7 miles per hour in July and August.

Geology, Physiography, and Drainage

Carroll and Haralson Counties lie within the Piedmont Plateau. About 85 percent of the two counties is underlain by schist, phyllite, biotite gneiss, and other metamorphic rocks (2). The remaining 15 percent is underlain by Augen gneiss, granite gneiss, hornblende gneiss, and other igneous rocks.

The elevation of the survey area ranges from 700 to about 1,600 feet above sea level. One of the highest elevations is Blackjack Mountain, 1,550 feet. The lowest elevation is where the Chattahoochee River leaves Carroll County. The elevation ranges from 1,000 to 1,600 feet in the uplands and from 700 to 1,000 feet in the bottom lands. In the bottom lands the soils are nearly level and generally narrow. In most of the uplands the soils are gently sloping or rolling, but some soils along drainageways are strongly sloping.

The Chattahoochee River flows southwesterly along the southeastern edge of Carroll County and drains 25 percent of the survey area. The Little Tallapoosa River roughly parallels the Chattahoochee River and drains most of Carroll County and 40 percent of the total survey area. The Tallapoosa River flows southwesterly. It drains the largest part of Haralson County and about 35 percent of the two counties.

Water Supply

The rivers and streams of the survey area are excellent sources of water for towns, industries, and irrigation, but on most farms, shallow wells are dug to provide water for domestic use. These wells commonly yield 2 to 5 gallons of water per minute and are less than 60 feet deep. Drilled wells are replacing dug wells for many rural homes. These drilled wells are commonly 6 or 8 inches in diameter and 100 to 250 feet deep. They generally yield 6 to 10 gallons of water per minute.

About 700 farm ponds are in the two counties, and they are used for watering livestock and poultry, for irrigation, and for fishing and other recreation.

The water table is generally highest in April and May and lowest in October and November. Contrary to popular belief, it is not falling each successive year, except in a few small areas. Where the water table falls in a large area, this fall probably is caused by a decrease in the amount of rainfall in the area.

Farming

The total land area of Carroll and Haralson Counties is 499,200 acres, and of this area, 214,421 acres was in farms, according to the 1964 Census of Agriculture. The total number of farms was 1,993. The average-sized farm was about 115 acres. Farms averaging 50 acres or less numbered 1,161, and farms averaging from 50 to 200 acres per farm numbered 70.

In recent years a significant change in land use has been from crops to pasture, woodland, or homesites. Pulpwood companies have acquired 60,191 acres in the area and planted the open land to forest. In 1964, the Bureau of the Census reported 20,037 acres in crops, 22,831 in improved pasture, and 102,641 acres in woods.

According to the 1959 Census of Agriculture, there were 4,065 acres planted to cotton, but according to local sources, by 1968 the area in cotton had been reduced to 565 acres. The diverted acreage has ben planted largely to improved pasture. The principal crop in 1968 was corn, and its area was about 10,000 acres.

According to a count by the local county agents, on January 1, 1966, there were 25,700 cattle on farms in Carroll and Haralson Counties.

Literature Cited

(1) American Association of State Highway Officials.
1961. Standard specifications for highway materials and methods of sampling and testing. Ed. 8, 2 v., illus., Washington, D.C.

(2) Georgia Division of Mines, Mining and Geology.
1939. Geologic map of Georgia. Prepared by Ga. Div. of Mines, Mining and Geol., in cooperation with the U.S. Dept. of Int., Geol. Survey, 1 p.

(3) Simonson, Roy W.
1962. Soil classification in the United States. Sci. 137: 1027–1034.

(4) United States Department of Agriculture.
1929. Volume, yield, and stand tables for second-growth southern pines. Misc. Publ. 50, 202 pp. Washington, D.C. [Now out of print.]

(5) ———
1951. Soil survey manual. U.S. Dept. of Agr. Handb. No. 18, 503 pp., illus.

(6) ———
1960. Soil classification, a comprehensive system, 7th approximation. 265 pp., illus. [Supplement issued in March 1967.]

(7) ———
1960. Management and inventory of southern hardwoods. U.S. Dept. of Agr. Handb. No. 181, 102 pp., illus.

(8) Waterways Experiment Station, Corps of Engineers.
1953. Unified soil classification system. Tech. Memo. 3–357, 2 v. and app., illus.

lossary

cidity (see *Reaction*).

ggregate, soil. Many fine particles held in a single mass or cluster, such as a clod, crumb, block, or prism.

lluvium. Soil material, such as sand, silt, or clay, that has been deposited on land by streams.

vailable water capacity. The capacity of a soil to hold water in a form available to plants. Amount of moisture held in soil between field capacity, or about one-third atmosphere of tension, and the wilting coefficient, or about 15 atmospheres of tension.

edrock. The solid rock that underlies the soil and other unconsolidated material or that is exposed at the surface.

lay. As a soil separate, the mineral soil particles less than 0.002 millimeter in diameter. As a soil textural class, soil material that is 40 percent or more clay, less than 45 percent sand, and less than 40 percent silt.

oncretions. Grains, pellets, or nodules of various sizes, shapes, and colors consisting of concentrations of compounds, or of some soil grains cemented together. The composition of some concretions is unlike that of the surrounding soil. Calcium carbonate and iron oxide are examples of material commonly found in concretions.

onsistence, soil. The feel of the soil and the ease with which a lump can be crushed by the fingers. Terms commonly used to describe consistence are—

oose.—Noncoherent: will not hold together in a mass.

riable.—When moist, crushes easily under gentle pressure between thumb and forefinger and can be pressed together into a lump.

irm.—When moist, crushes under moderate pressure between thumb and forefinger, but resistance is distinctly noticeable.

Plastic.—When wet, readily deformed by moderate pressure but can be pressed into a lump; will form a "wire" when rolled between thumb and forefinger.

Sticky.—When wet, adheres to other material, and tends to stretch somewhat and pull apart, rather than to pull free from other material.

Hard.—When dry, moderately resistant to pressure; can be broken with difficulty between thumb and forefinger.

Soft.—When dry, breaks into powder or individual grains under very slight pressure.

Cemented.—Hard and brittle; little affected by moistening.

rosion. The wearing away of the land surface by wind, running water, and other geological agents.

ertility, soil. The quality of a soil that enables it to provide compounds, in adequate amounts and in proper balance, for the growth of specified plants, when other growth factors, such as light, moisture, temperature, and the physical condition (or tilth) of the soil, are favorable.

irst bottom. The normal flood plain of a stream, subject to frequent or occasional flooding.

lood plain. Nearly level land, consisting of stream sediments, that borders a stream and is subject to flooding unless protected artificially.

ragipan. A dense, brittle subsurface horizon that is very low in organic matter and clay but rich in silt or very fine sand. The layer seems to be cemented when it is dry, is hard or very hard, and has a high bulk density in comparison with the horizon or horizons above it. When moist, the fragipan tends to rupture suddenly if pressure is applied, rather than to deform slowly. The layer is generally mottled, is slowly or very slowly permeable to water, and has few or many bleached fracture planes that form polygons. Fragipans are a few inches to several feet thick; they generally occur below the B horizon, 15 to 40 inches below the surface.

leyed soil. A soil in which waterlogging and lack of oxygen have caused the material in one or more horizons to be neutral gray in color. The term "gleyed" is applied to soil horizons with yellow and gray mottles caused by intermittent waterlogging.

Horizon, soil. A layer of soil, approximately parallel to the surface, that has distinct characteristics produced by soil-forming processes. These are the major horizons:

O horizon.—The layer of organic matter on the surface of a mineral soil. This layer consists of decaying plant residues.

A horizon.—The mineral horizon at the surface or just below an O horizon. This horizon is the one in which living organisms are most active and therefore is marked by the accumulation of humus. The horizon may have lost one or more of soluble salts, clay, and sesquioxides (iron and aluminum oxides).

B horizon.—The mineral horizon below an A horizon. The B horizon is in part a layer of change from the overlying A to the underlying C horizon. The B horizon also has distinctive characteristics caused (1) by accumulation of clay, sesquioxides, humus, or some combination of these; (2) prismatic or blocky structure; (3) redder or stronger colors than the A horizon; or (4) some combination of these. Combined A and B horizons are usually called the solum, or true soil. If a soil lacks a B horizon, the A horizon alone is the solum.

C horizon.—The weathered rock material, or substratum, immediately beneath the solum. In most soils this material is presumed to be like that from which the overlying horizons were formed. If the material is known to be different from that in the solum, a Roman numeral precedes the letter C.

R layer.—Consolidated rock beneath the soil. The rock usually underlies a C horizon but may be immediately beneath an A or B horizon.

Igneous rock. Rock that has been formed by the cooling of molten mineral material. Examples: Granite, syenite, diorite, and gabbro.

Infiltration rate. The rate at which water penetrates the surface of the soil at any given instant, usually expressed in inches per hour. It may be limited either by the infiltration capacity of the soil or by the rate at which water is applied to the surface soil.

Leaching. The removal of soluble materials from soils or other material by percolating water.

Metamorphic rock. Rocks of any origin that have been completely changed physically by heat, pressure, and movement. Such rocks are nearly always crystalline.

Morphology, soil. The makeup of the soil, including the texture, structure, consistence, color, and other physical, mineralogical, and biological properties of the various horizons of the soil profile.

Mottled. Irregularly marked with spots of different colors that vary in number and size. Mottling in soils usually indicates poor aeration and lack of drainage. Descriptive terms are as follows: Abundance—*few*, *common*, and *many*; size—*fine*, *medium*, and *coarse*; and contrast—*faint*, *distinct*, and *prominent*. The size measurements are these: *fine*, less than 5 millimeters (about 0.2 inch) in diameter along the greatest dimension; *medium*, ranging from 5 millimeters to 15 millimeters (about 0.2 to 0.6 inch) in diameter along the greatest dimension; and *coarse*, more than 15 millimeters (about 0.6 inch) in diameter along the greatest dimension.

Parent material. The horizon of weathered rock or partly weathered soil material from which soil has formed; horizon C in the soil profile.

Ped. An individual natural soil aggregate, such as a crumb, a prism, or a block, in contrast to a clod.

Permeability, soil. The quality of a soil horizon that enables water or air to move through it. Terms used to describe permeability are as follows: *Very slow*, *slow*, *moderately slow*, *moderate*, *moderately rapid*, *rapid*, and *very rapid*.

Plowed layer. The soil ordinarily moved in tillage; equivalent to surface soil.

Profile, soil. A vertical section of the soil through all its horizons and extending into the parent material. See Horizon, soil.

Reaction, soil. The degree of acidity or alkalinity of a soil, expressed in pH values and in words as follows:

	pH		*pH*
Extremely acid	Below 4.5	Mildly alkaline	7.4 to 7.8
Very strongly acid	4.5 to 5.0	Moderately alkaline	7.9 to 8.4
Strongly acid	5.1 to 5.5	Strongly alkaline	8.5 to 9.0
Medium acid	5.6 to 6.0	Very strongly alkaline	9.1 and higher
Slightly acid	6.1 to 6.5		
Neutral	6.6 to 7.3		

REFERENCE 3

U.S. DEPARTMENT OF COMMERCE
C. R. Smith, Secretary

ENVIRONMENTAL SCIENCE SERVICES ADMINISTRATION
Robert M. White, Administrator

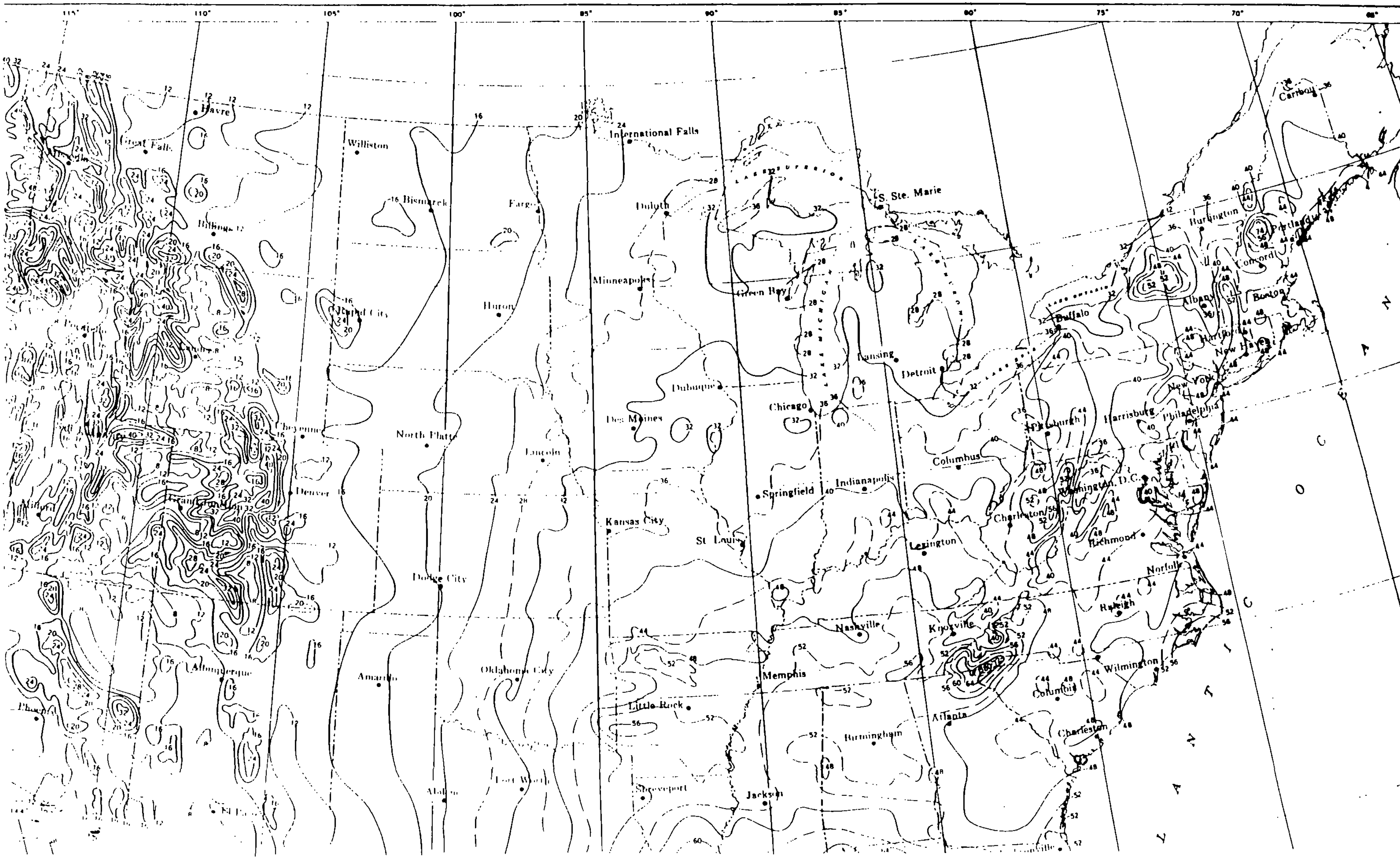
ENVIRONMENTAL DATA SERVICE
Woodrow C. Jacobs, Director

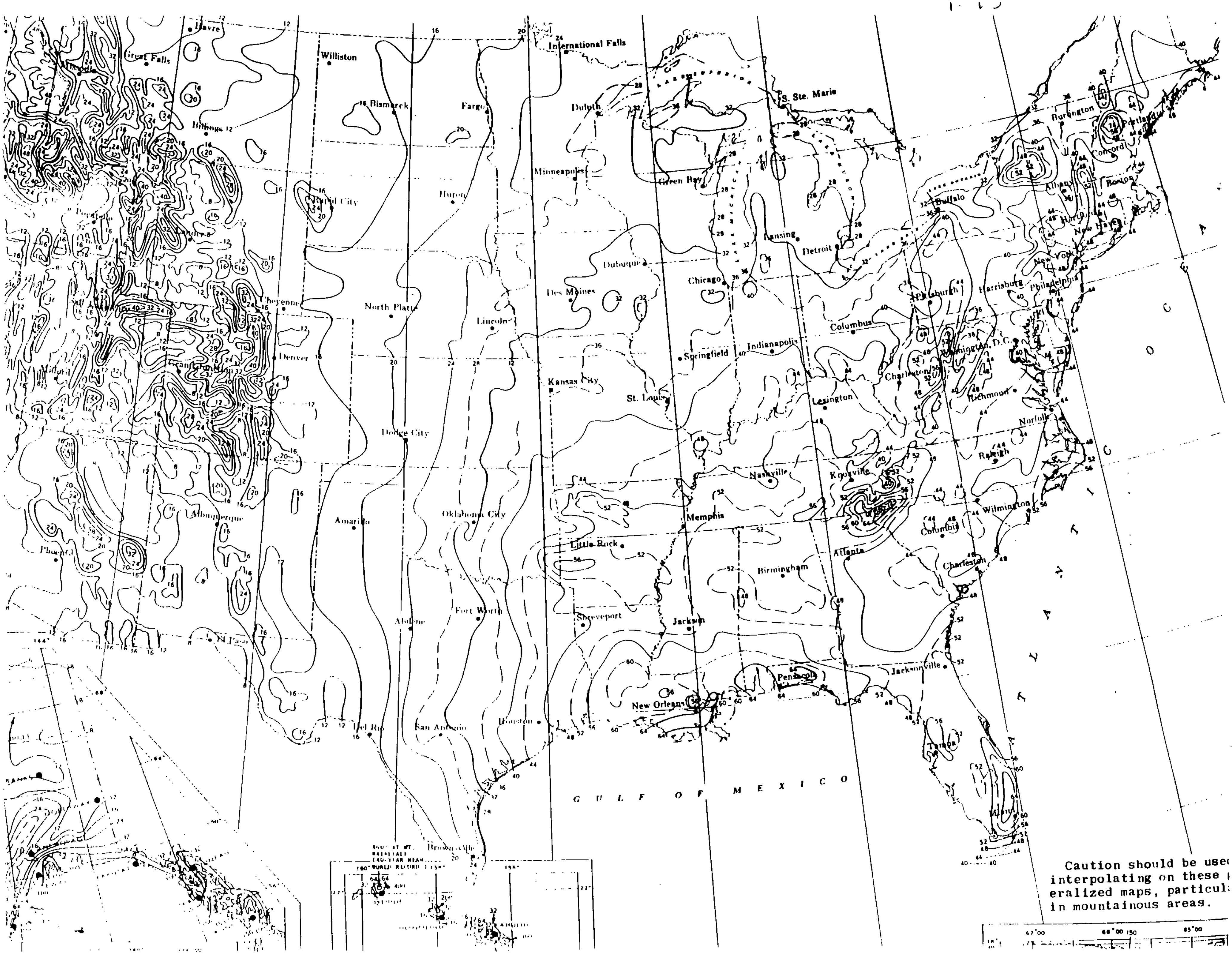
JUNE 1968

REPRINTED BY THE
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION
1983

NORMAL ANNUAL TOTAL PRECIPITATION (Inches)

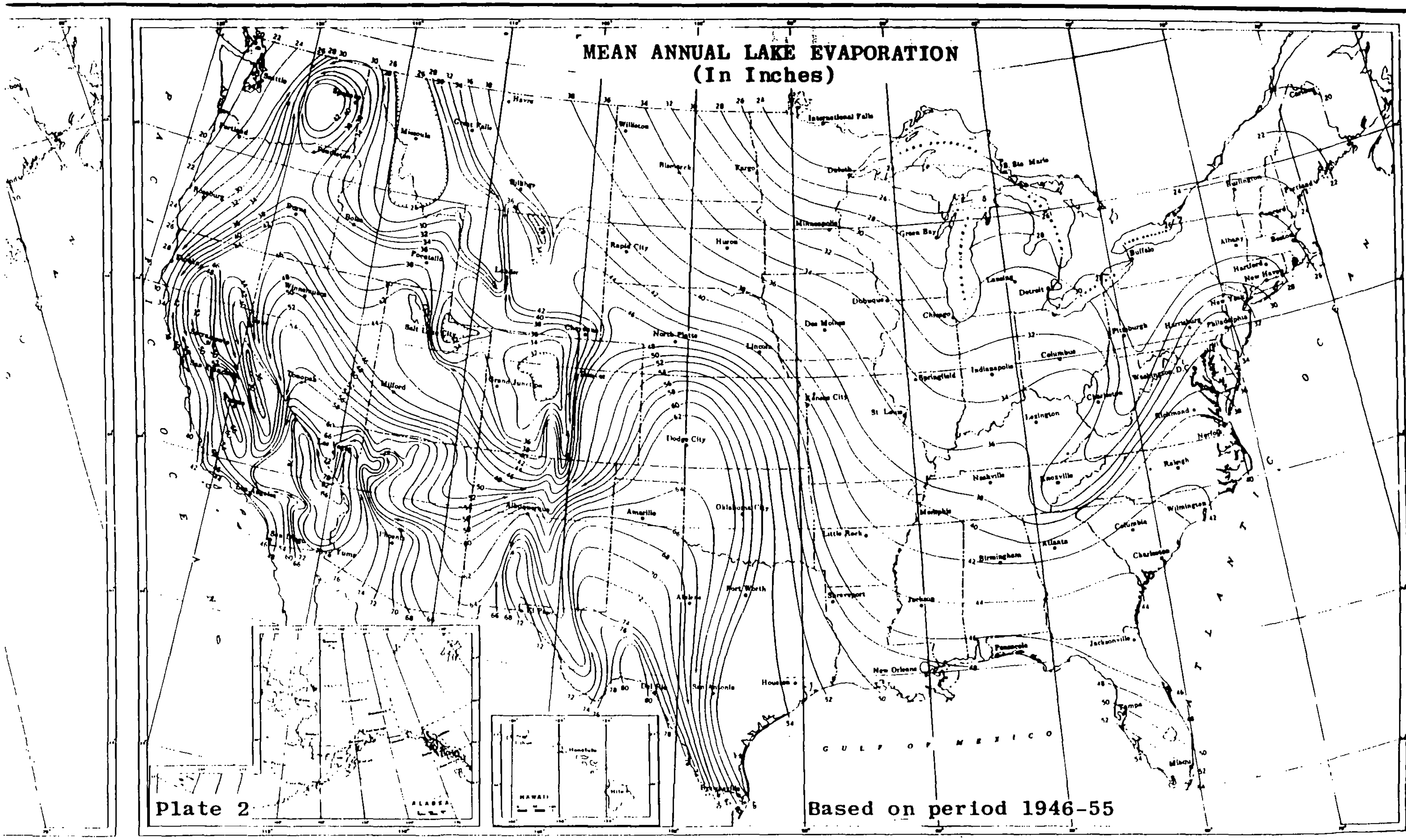
P. 43

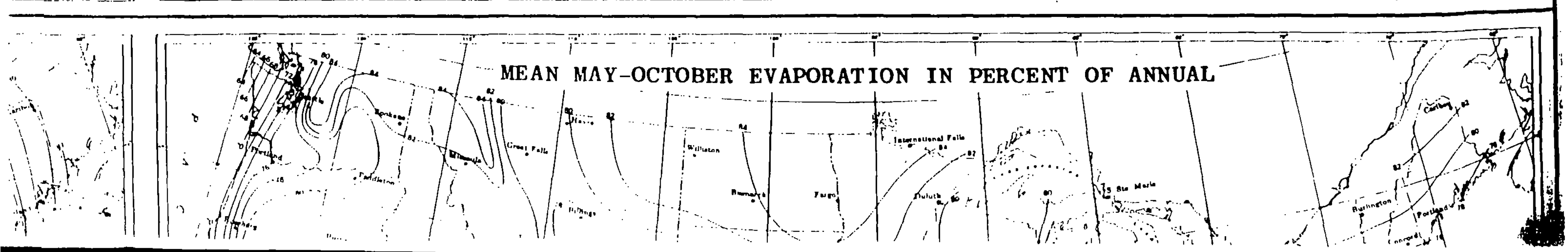




Caution should be used in interpolating on these generalized maps, particularly in mountainous areas.

P. 63


MEAN ANNUAL LAKE EVAPORATION
(In Inches)
GULF OF MEXICO
ALASKA
HAWAII
Plate 2
Based on period 1946-55


MEAN MAY-OCTOBER EVAPORATION IN PERCENT OF ANNUAL

DEPARTMENT OF COMMERCE
... H. Hodges, Secretary

WEATHER BUREAU
F. W. Reichelderfer, Chief

REFERENCE 4

TECHNICAL PAPER NO. 40

RAINFALL FREQUENCY ATLAS OF THE UNITED STATES

for Durations from 30 Minutes to 24 Hours and Return Periods from 1 to 100 Years

Prepared by
DAVID M. HERSHFIELD
Cooperative Studies Section, Hydrologic Services Division

for

Engineering Division, Soil Conservation Service
U.S. Department of Agriculture

PRICE LIST: RAINFALL FREQUENCY ATLASES

October 1985

National Climatic Data Center
Federal Building
Asheville, NC 28801-2696
704 CLI-MATE or 704-259-0682
Telex 6502643731

The atlases described below may be ordered on one reel of 35mm microfilm at $12.50, or as individual paper pages at $2 per page, $4 service and handling charge per order. (Prices subject to change without notice.) Call to confirm current price.

TP-40: Rainfall Frequency Atlas of the US - Weather Bureau Technical Paper No. 40 (Washington, DC: GPO, 1961) 14x21 ins, paper cover, 61 pages. (Superseded in part by two publications listed below.)

Presents 49 US rainfall frequency maps for selected durations from 30 minutes to 24 hours and return periods from 1 to 100 years. OUT-OF-PRINT, but a 8 1/2x14 in. reduced photocopy priced at $15 is available from the NCDC address above. Make payment to "Commerce-NOAA-NCDC".

HYDRO-35: Five- to 60-Minute Precipitation Frequency for the Eastern and Central US - NOAA Technical Memorandum NWS HYDRO-35 (Silver Spring, MD: NWS, 1977) 8 1/2x11 ins, cardstock cover, 36 pages. (Supersedes TP-40 above for the eastern 2/3 of the US for durations of 1 hr. and less).

Presents 6 US rainfall frequency maps for durations of 5, 15 and 60 minutes at return periods of 2 and 100 years. Equations are given to derive 10- and 30-min values between 2 and 100 years.

Order from: National Technical Info. Svc.
5285 Port Royal Rd.
Springfield, VA 22161
Order Desk Phone: 703-487-4650

Order No : PB 272-112
Prices: Paper $8.50
Microfiche $4.50

NOAA Atlas 2: Precipitation Frequency Atlas of the Western US (Washington, DC: GPO, 1973) 16x22 ins, cardstock cover, 11 Vols (Supersedes TP-40 above for the 11 western states) OUT OF PRINT.

This atlas contains maps for the 6- and 24-hour durations for return periods of 2, 5, 10, 25, 50, and 100 years. All maps are prepared on the same 1:2,000,000 scale.

Vol.	State	Pages	Photocopy Price
I	Montana	34	$ 68.00
II	Wyoming	34	$ 68.00
III	Colorado	47	$ 94.00
IV	New Mexico	34	$ 68.00
V	Idaho	35	$ 70.00
VI	Utah	46	$ 92.00
VII	Nevada	35	$ 70.00
VIII	Arizona	33	$ 66.00
IX	Washington	35	$ 70.00
X	Oregon	35	$ 70.00
XI	California	48	$ 96.00

(Note: Topographic contours and city names not always legible on microprints of NOAA Atlas 2. Blank, numbered pages are not reproduced, resulting in apparent missing pages, but no data pages are missing.)

$4 SERVICE AND HANDLING CHARGE PER ORDER.

PREFACE

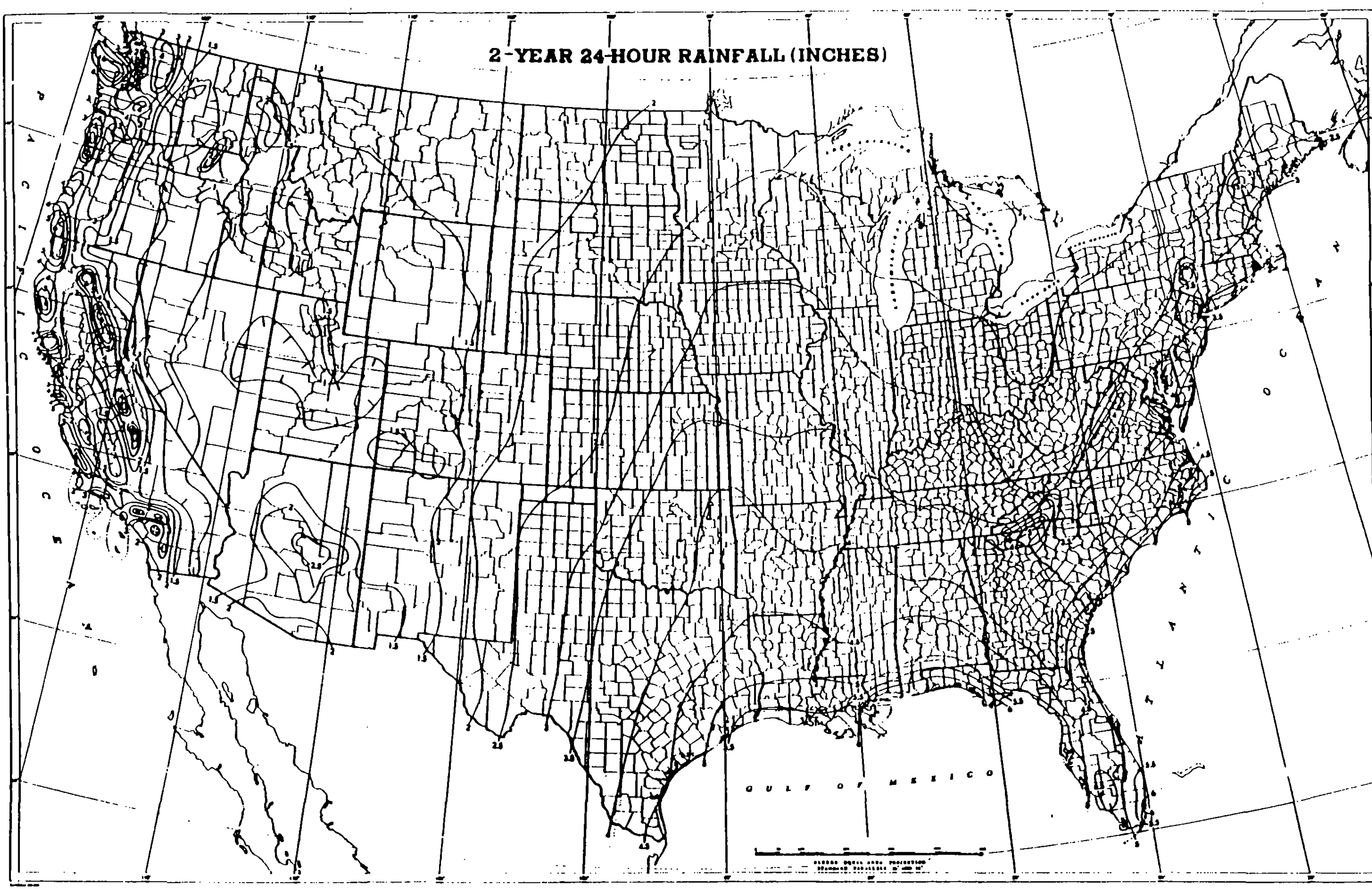
This publication is intended as a convenient summary of empirical relationships, working guides, and maps, useful in practical problems requiring rainfall frequency data. It is an outgrowth of several previous Weather Bureau publications on this subject prepared under the direction of the author and contains an expansion and generalization of the ideas and results in earlier papers. This work has been supported and financed by the Soil Conservation Service, Department of Agriculture, to provide material for use in developing planning and design criteria for the Watershed Protection and Flood Prevention program (P.L. 566, 83d Congress and as amended).

The paper is divided into two parts. The first part presents the rainfall analyses. Included are measures of the quality of the various relationships, comparisons with previous works of a similar nature, numerical examples, discussions of the limitations of the results, transformation from point to areal frequency, and seasonal variation. The second part presents 49 rainfall frequency maps based on a comprehensive and integrated collection of up-to-date statistics, several related maps, and seasonal variation diagrams. The rainfall frequency (isopluvial) maps are for selected durations from 30 minutes to 24 hours and return periods from 1 to 100 years.

This study was prepared in the Cooperative Studies Section (Joseph L. H. Paulhus, Chief) of Hydrologic Services Division (William E. Hiatt, Chief). Coordination with the Soil Conservation Service, Department of Agriculture, was maintained through Harold O. Ogrosky, Chief, Hydrology Branch, Engineering Division. Assistance in the study was received from several people. In particular, the author wishes to acknowledge the help of William E. Miller who programmed the frequency and duration functions and supervised the processing of all the data; Normalee S. Foat who supervised the collection of the basic data; Howard Thompson who prepared the maps for analysis; Walter T. Wilson, a former colleague, who was associated with the development of a large portion of the material presented here; Max A. Kohler, A. L. Shands, and Leonard L. Weiss, of the Weather Bureau, and V. Mockus and R. G. Andrews, of the Soil Conservation Service, who reviewed the manuscript and made many helpful suggestions. Caroll W. Gardner performed the drafting.

CONTENTS

Chart 44



2-YEAR 24-HOUR RAINFALL (INCHES)
PACIFIC OCEAN
ATLANTIC OCEAN
GULF OF MEXICO

REFERENCE 5

HALLIBURTON NUS ENVIRONMENTAL CORPORATION		*TELECON NOTE*
CONTROL NO. 2T38	**DATE:** 2/26/93	**TIME:** 1530
DISTRIBUTION: File: (GA Power, Wansley Steam Plant)		
BETWEEN: Don Holder	**OF:** GA Power	**PHONE:** (404) 526-7778
AND: Steve Petrides, Halliburton NUS		

DISCUSSION:

Mr. Holder updated me with the following information concerning GA Power, Plant Wansley:

- The plant is still operating and has since 1976 and will continue for another 40 years
- The number of workers at the site probably hasn't changed that much in the last 3 years and is probably still around 325
- The ownership history has not changed and is still owned jointly by GA Power, Oglethorpe Power Municipal Electric Authority of GA and the city of Dalton, Georgia
- The RCRA status has not changed and is still classified as a generator.

REFERENCE 6

R-586-10-1-47

10 9 1 — 5 S P 6/25/9

FINAL REPORT

SITE INSPECTION
GEORGIA POWER - WANSLEY STEAM ELECTRIC GENERATING PLANT
ROOPVILLE, HEARD COUNTY, GEORGIA
EPA ID NO.: GAD000612937

Prepared Under
TDD No. F4-8909-62
Contract No. 68-01-7346

Revision 0

FOR THE

WASTE MANAGEMENT DIVISION
U.S. ENVIRONMENTAL PROTECTION AGENCY

OCTOBER 17, 1991

HALLIBURTON NUS ENVIRONMENTAL CORPORATION
SUPERFUND DIVISION

Prepared By	Reviewed By	Approved By
Eric Carlin for		
John Jenkins Project Manager		Phil Blackwell Regional Project Manager

NOTICE

The information in this document has been funded wholly by the United States Environmental Protection Agency (EPA) under Contract Number 68-01-7346 and is considered proprietary to the EPA.

This information is not to be released to third parties without the expressed or written consent of the EPA.

TABLE OF CONTENTS

TABLES

FIGURES

EXECUTIVE SUMMARY

The Georgia Power, Wansley Steam Electric Generating Station is located east of Highway 27 off of Friendship Road along the Carroll County and Heard County border (Figure 1). The plant property covers approximately 5,225 acres.

The plant is currently active and began operations in 1976 (Refs. 1, 2). The plant has always been operated by Georgia Power; although, the plant is jointly owned by Georgia Power Company, Oglethorpe Power Corporation, the Municipal Electric Authority of Georgia and the city of Dalton, Georgia (Ref. 2).

The primary objective of plant operations is generating electricity by boiling water in large tanks in order to produce steam that turns turbines that generate electricity (Ref. 2). Coal and/or oil is used as fuel to boil the water (Ref. 2).

The facility is located within the Piedmont physiographic province. Geologic units that underlie the property consist of a surficial residual soil layer resting upon crystalline bedrock consisting of amphibolite, hornblende, and biotite gneisses. The residuum and the underlying crystalline rock contain the unconfined (surficial) aquifer which is the aquifer of concern in the study area. Groundwater occurrence in the crystalline rock is limited to secondary porosity openings such as joints and fractures; whereas, groundwater within the residuum is present in the intergranular pore spaces in the soil.

The groundwater pathway is of primary concern at Georgia Power. The unconfined crystalline rock aquifer is the aquifer of concern in the study area. Approximately 1,553 residents in the study area obtain water from private wells completed in this aquifer. The surface water pathway is also of concern because recreational boating and fishing are common activities in waters onsite (except for the Ash Pond and effluent) and downstream. The onsite exposure pathway is a concern due to the number of employees (approximately 325) working at the facility. The air exposure pathway is of limited concern due to the facility's rural setting.

The sampling investigation consisted of the collection of 33 environmental samples: two surface soil samples, six subsurface soil samples, four groundwater samples, ten surface water samples, and eleven sediment samples.

Organic analysis identified presumptive evidence of the presence of Trichlorotrifluoroethane in estimated concentrations in subsurface soils and sediments throughout much of the study area. Trichlorotrifluoroethane is a volatile compound that is commonly used as a degreasing solvent and an insulating fluid in transformers. Polynuclear aromatic compounds (PNAs) were identified (presumptive and estimated) in sediment samples collected from the two Coal Pile Run-off Ponds as well as the Ash Pond. These may be attributable to creosote from nearby railroad tracks or the coal used at the facility. Presumptive evidence of petroleum product was also indicated in sediment samples. Also, elevated levels of pesticides were identified in sediment samples collected from the Coal Pile Run-off Ponds as well as in the Ash Pond.

Inorganic analytes were identified as elevated in surface soils, subsurface soils, groundwater, surface water, and sediment samples. Since the groundwater and surface water pathways are of the greatest concern in this investigation the most notable findings were identified in groundwater and surface water samples. Chromium (7 times control) and lead (12 times control) were detected in the groundwater sample collected near the Ash Pond. Chromium (14 times control) was also detected in a groundwater sample collected near the Cooling Water Retention Pond. Some of the groundwater samples collected during the field investigation contained levels which exceeded the Maximum Contaminant Levels (MCLs) for primary drinking water standards for chromium, lead, and nickel.

Some of the surface water samples collected contained elevated levels of aluminum, barium, calcium, iron, manganese, potassium, sodium, and vanadium. Also,Maximum Contamination Levels (MCLs) for primary drinking water standards were reached or exceeded for nickel and selenium.

Considering the number of groundwater targets in the area as well as surface water and onsite exposure targets, it is recommended that this facility be evaluated using the HRS (effective March 14, 1991).

1.0 INTRODUCTION

The HALLIBURTON NUS Environmental Corporation Region 4 Field Investigation Team (FIT) was tasked by the U.S. Environmental Protection Agency (EPA), Waste Management Division to conduct a Site Inspection (SI) at the Georgia Power Wansley in Roopville, Heard County, Georgia.. The investigation was performed under the authority of the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA) and the Superfund Amendments and Reauthorization Act of 1986 (SARA). The task was performed to satisfy the requirements stated in Technical Directive Document (TDD) number F4-8909-62. The field investigation was conducted the week of September 17, 1990.

1.1 OBJECTIVES

The objectives of this inspection were to determine the nature of contaminants present at the site and to determine if a release of these substances has occurred or may occur. Further, this inspection sought to determine the possible pathways by which contamination could migrate from the site and the populations and environments it would potentially affect. Through these objectives, a recommendation was made regarding future activities at the site.

1.2 SCOPE OF WORK

The objectives were achieved through the completion of a number of specific tasks. These activities were to:

- Obtain and review relevant background materials.

- Obtain information on local water systems.

- Determine location of and distance to nearest potable well.

- Evaluate target populations and environments associated with the groundwater, surface water, air, and soil exposure pathways.

- Develop a site sketch.

- Collect environmental samples.

2.2 SITE DESCRIPTION

2.2.1 Site Features

As previously mentioned, the plant property occupies approximately 5,225 acres and employs approximately 325 people (Ref. 1). The property is bounded on the northern and western sides by wooded areas and the southern and eastern sides by wooded areas and the Chattahoochee River (Appendix A). There are two large lakes located approximately one-third of a mile northwest of the power plant. These lakes are both elongated southwest to northeast and are separated by an earth dike. Both of these lakes are supplied by numerous small feeder streams. The northeastern most of these two lakes (known as the Storage Water Pond) is largely supplied water by Yellow Dirt Creek which flows into the western end of the northern side of this lake. Yellow Dirt Creek also drains the Storage Water Pond at the eastern end. Drainage from this water body empties into the nearby Chattahoochee River. The southwestern most lake, known as the Ash Pond, is situated almost due west of the power plant and is used for both fly ash disposal and disposal of pretreated boiler washings (Appendix A) (Refs. 1; 2; 7). The Ash Pond is basically a closed basin that is equipped with an emergency spillway located at the south-central end of the pond (Figure 2). The spillway directs overflow water southward via a concrete lined ditch to a retention pond located southwest of the plant (Ref. 1). The Retention Pond is unlined and also receives cooling water discharge from the plant (Ref. 1). Cooling water enters the Retention Pond from an unlined ditch from the eastern side of the pond (Ref. 1). Water from the Retention Pond is released via a NPDES permitted (Permit No. GA0024778) unlined ditch into the Chattahoochee River (Refs. 1; 2). Other notable features include two landfills that were used for construction debris disposal during building the plant. One of these landfills, the Large Construction Landfill, is between 4 and 5 acres in size and is located south of the Ash Pond (Figure 2, Ref. 1). The other construction landfill, the Small Construction Landfill, occupies approximately 1 acre and is located south of the Storage Water Pond (Figure 2) (Ref. 1). Both of the construction landfills are inactive and were covered with grass in 1980 (Ref. 1). There is a third landfill located southeast of the Large Construction Landfill (Figure 2). This landfill, known as the Inert Landfill, is active and has been used for disposal of inert materials since either 1983 or 1984 (Ref. 1).

There is a large coal pile located just north and adjacent to the power plant (Figure 2). Also, there are small unlined precipitation run-off ponds at the southwestern and northeastern ends of the coal pile. There are also railroad tracks surrounding the coal pile (Figure 2).

2.0 SITE CHARACTERIZATION

2.1 SITE HISTORY

The Georgia Power, Wansley Steam Electric Generating Station is located east of Highway 27 off of Friendship Road along the Carroll County and Heard County border (Figure 1). The plant property covers approximately 5,225 acres, the majority of which is located in Heard County; however, there are portions of the property which extend into Carroll County (Appendix A).

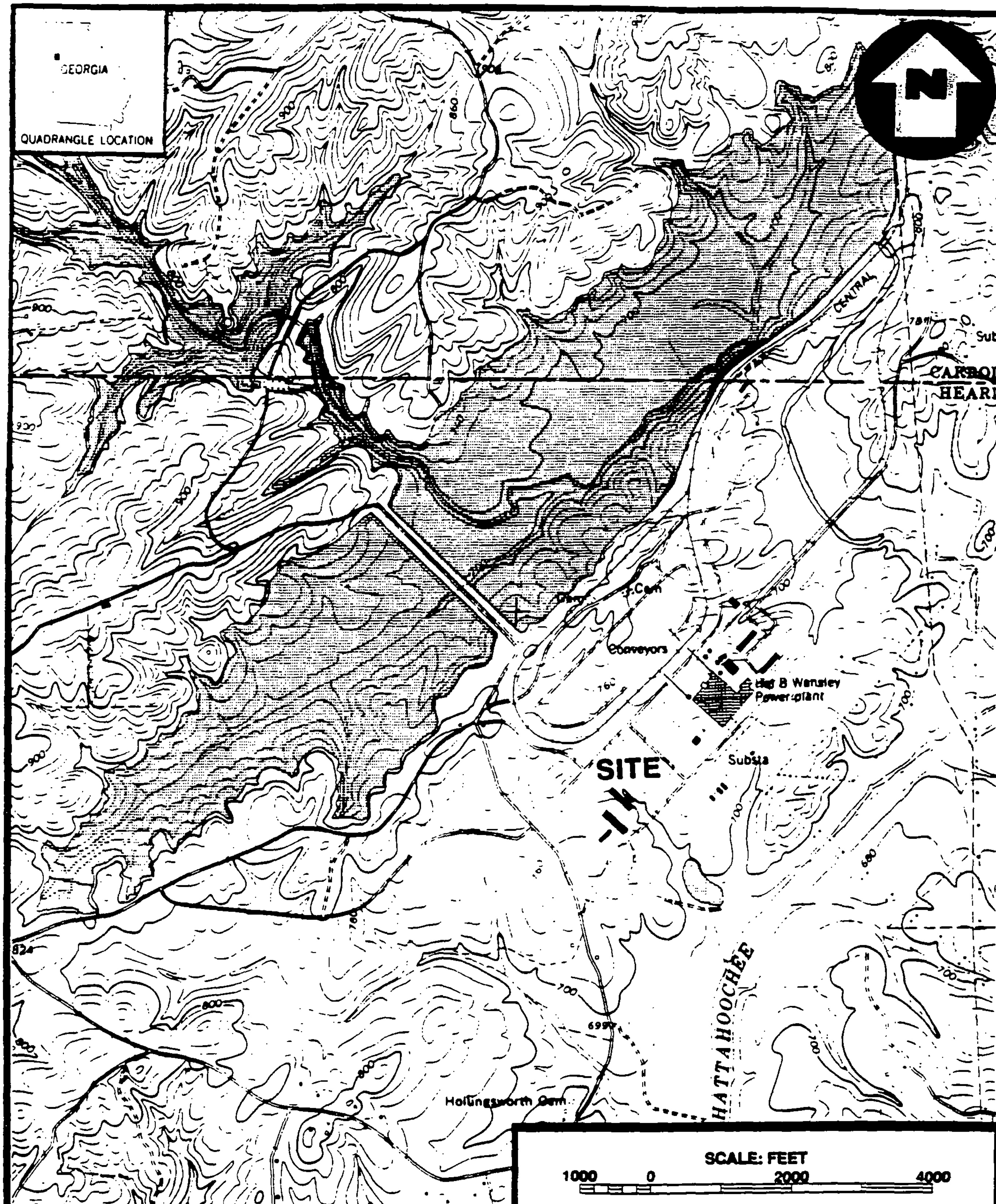
The plant is currently active and began operations in 1976 (Refs. 1, 2). The plant has always been operated by Georgia Power; although, the plant is jointly owned by Georgia Power Company, Oglethorpe Power Corporation, the Municipal Electric Authority of Georgia and the city of Dalton, Georgia (Ref. 2).

The primary objective of plant operations is generating electricity by boiling water in large tanks in order to produce steam that turns turbines that generate electricity (Ref. 2). Coal and/or oil is used as fuel to boil the water (Ref. 2).

Wastes generated at the plant include fly ash from burning coal, washings from boiler cleanings, and wastes generated from routine maintenance activities (Refs. 1, 2). Also, the facility at one time utilized PCB transformers; however, these were reportedly "changed out" with updated non-PCB type transformers and shipped to an authorized disposal facility (Ref. 1). Documentation of waste disposal activities (for wastes other than fly ash) prior to 1980 are unavailable (Ref. 2).

Waste fly ash and the majority of boiler cleaning waste (after neutralization) is pumped via pipeline into an unlined large lake known as the Ash Pond (Refs. 1; 2, Appendix A). Since 1980, all hazardous waste disposal practices at the facility have been in compliance with the Georgia Rules for Hazardous Waste Management (Ref. 2).

On November 18, 1980, the Georgia Power, Wansley Steam Electric Generating Station filed a RCRA Part A application (EPA Form 3510-1) as a TSD facility (Ref. 3). On August 15, 1983, the plant withdrew the aforementioned RCRA permit in order to be reclassified as a generator only with interim status (Ref. 4). However, it was later determined that the plant was a protective filer and never actually needed Interim Status (Ref. 5). Currently, the facility is still classified as a generator only (Refs. 1; 5).

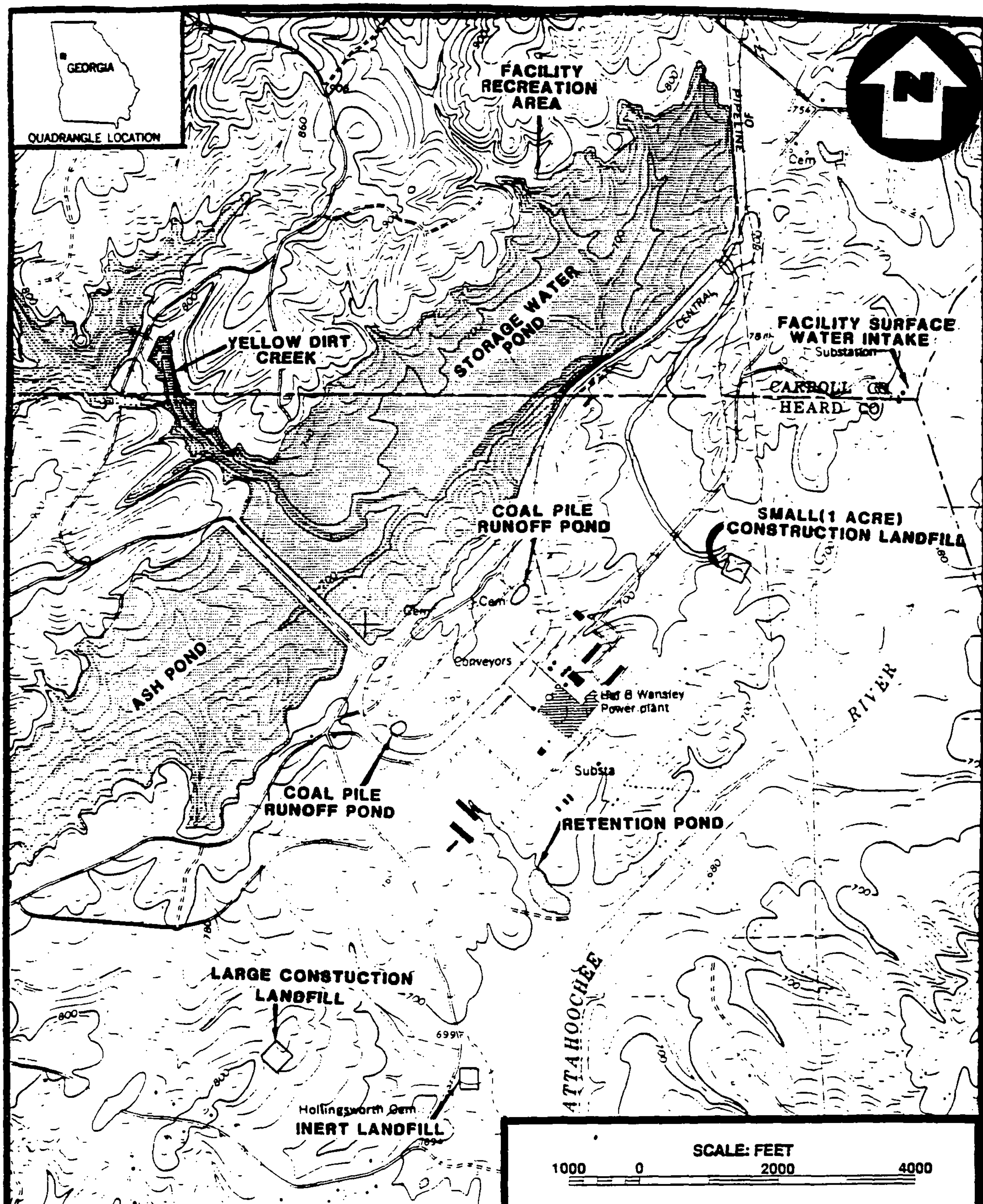


BASE MAP IS A PORTION OF THE U.S.G.S. 7.5 MINUTE QUADRANGLE LOWELL, 1964 GEORGIA.

SITE LOCATION MAP
GEORGIA POWER - PLANT WANSLEY
ROOPVILLE, HEARD COUNTY, GEORGIA

FIGURE 1

NUS CORPORATION



BASE MAP IS A PORTION OF THE U.S.G.S. 7.5 MINUTE QUADRANGLE LOWELL, GEORGIA 1982.

SITE LAYOUT MAP
GEORGIA POWER-PLANT WANSLEY
ROOPVILLE, HEARD COUNTY, GEORGIA

FIGURE 2

NUS CORPORATION

2.2.2 Waste Characteristics

Wastes generated at the facility include fly ash, boiler cleaning washings, and wastes generated from miscellaneous maintenance activities (primarily painting) (Refs. 2, 3, 7). The vast majority of the waste generated at the plant is fly ash. Inorganic constituents of fly ash typically include sodium, calcium, magnesium, and iron and may contain various other inorganic ions (Refs. 8; 9). According to 40 CFR 261.4(b) (No. 4), neither the fly ash waste or the waste generated from boiler cleaning are considered to be hazardous wastes (Refs. 10; 11). The types of hazardous wastes handled at the power plant, according to the Part A application that the facility filed, include halogenated and non-halogenated solvents; carbon disulfide, phosphorothioic acid; acetone, 2-methyl benzenamine hydrochloride; 2,6-dinitrotoluene; 1,1,1 trichloroethane, tetrachloroethene; formaldehyde; formic acid; hydrofluoric acid; mercury; tetrachloromethane; methanol, phenol; toluene; and methyl ethyl ketone (Refs. 10; 11, pp. 405-435; 12). Since 1980, these wastes have been drummed, temporarily stored, and shipped to either Chemical Waste Management (ALD000622464) or Safety Kleen Corporation (GAD000823070) for disposal or reclamation (Refs. 10; 12). The ash and boiler washings, as previously mentioned, are piped to the Ash Pond for disposal (Refs. 1; 2; 7).

3.0 REGIONAL POPULATIONS AND ENVIRONMENTS

3.1 POPULATION AND LAND USE

3.1.1 Demography

The Georgia Power, Wansley Steam Electric Generating Station is located in a rural area in northeastern Heard County, Georgia (Appendix A). Population within 0.5 mile is zero, and the population within 1 mile is approximately 187 (68 homes x 2.75) (Ref. 13, Appendix A). The respective populations from 1 to 2, 2 to 3, and 3 to 4 miles from the facility are 385 (140 x 2.75), 679 (247 x 2.75), and 2,215 (Appendix A, Refs. 13; 14). The total population within 4 miles of the property is approximately 3,466 (Appendix A, Refs. 13; 14). The residence nearest the property is located approximately 0.5 mile north adjacent to Liberty Church Road (Appendix A).

3.1.2 Land Use

The majority of the land surrounding the facility is wooded (Appendix A). Historically, much of this area has been utilized for farming; however, pulpwood companies have purchased a significant number of these farms and have converted them into forest (Ref. 15, p. 59). There are no schools or day-care centers in the vicinity of the power plant, and the nearest communities are present west and north of the plant (Appendix A). The only communities within 4 miles of the power plant are Glenloch, located approximately 1.5 miles west of plant property, and Lowell, which is located approximately 2.5 miles to the north (Appendix A).

There are no federally-designated endangered species specifically known to be present within the study area. However. four federally-designated endangered species; the Florida panther (Felis concolor coryi), the bald eagle (Haliaeetus loucocephalus), the Bachman's warbler (Vermivora bachmanii), and the red-cockaded woodpecker (Picoides (= Dendrocopos) borealis); have ranges that include the study area (Ref. 16).

3.2 SURFACE WATER

3.2.1 Climatology

The climate in the study area is characterized by long and moderately hot summers and short, mild winters (Ref. 15, p. 1). The areas normal annual precipitation is approximately 50 inches; and the net annual rainfall is approximately 8 inches (Ref. 17, pp. 43, 63). The 2-year, 24-hour rainfall is approximately 4 inches (Ref. 18, p. 95).

3.2.2 Overland Drainage

There are three primary drainage pathways exiting the property (Appendix A). One of these pathways originates at the Ash Pond. This route allows for overflow to exit the southern side of the Ash Pond via a concrete lined ditch. This ditch leads to an unlined retention pond located southwest of the power plant. This retention pond also receives cooling water discharge from the power plant. The retention pond is drained by an unlined ditch (approximately 1,000 feet in length) which empties into the Chattahoochee River (Appendix A; Ref. 1). This pathway is monitored via a NPDES permit (Refs. 1; 2).

Another major drainage system at the plant is centered at the Storage Water Pond (Appendix A). This pond is fed by Yellow Dirt Creek which flows into the western end of the northern side of this pond (Figure 2). This system is also drained by Yellow Dirt Creek at the eastern end of the pond (Figure 2). Upon flowing out of the Storage Water Pond, Yellow Dirt Creek flows southward approximately 1.7 miles before entering the Chattahoochee River (Figure 2).

The remaining pathway consists of a small tributary of the Chattahoochee River located near the southwestern end of the property (Figure 2). This tributary flows between the Large Construction Landfill and the Inert Landfill (Figure 2). This pathway flows a maximum of 2 miles prior to reaching the confluence with the Chattahoochee River (Appendix A). This pathway enters the Chattahoochee River at the most downstream point compared to the other two aforementioned pathways (Figure 2). From this confluence, the migratory pathway is completed along the Chattahoochee River (Appendix A).

3.2.3 Potentially Affected Water Bodies

The only offsite body of water that could potentially be affected is the Chattahoochee River (Appendix A). The Chattahoochee River as well as all onsite surface waters (other than the Ash Pond) are utilized for recreational boating and fishing (Refs. 19; 20). The nearest downstream potable intake is approximately 30 stream miles away and owned/operated by the city of LaGrange Water Department (Ref. 20). There are no federally designated endangered or threatened species identified to be present along the surface water migratory pathway (Ref. 16).

3.3 GROUNDWATER

3.3.1 Hydrogeology

The Georgia Power - Plant Wansley facility is located in the Piedmont physiographic province and the Piedmont Blue Ridge hydrogeologic setting (Refs. 21, p. 3; 22, pp. 251, 252). The facility is situated along the Chattahoochee River in the northeast corner of Heard County. The area is characterized by rolling hills with moderate relief. Elevations in the vicinity average approximately 800 feet above mean sea level (amsl) (Appendix A).

The Piedmont province is characterized by massive igneous and metamorphic rocks which have been warped and faulted into complex folds and refolded folds by regional stresses (Ref. 23, p. 7). The southwestern edge of the Brevard fault zone, a major northeast-southwest trending structural feature in the Atlanta area, is located beneath the property (Ref. 23, plate 1). This area is typified by crystalline bedrock overlain by a thin veneer residual soil and weathered rock called regolith.

The crystalline bedrock and weathered rock beneath the Georgia Power - Plant Wansley property consists of amphibolite, hornblende, and biotite gneisses (Ref. 21, plates IB West, II). Groundwater in this residual soil/crystalline rock aquifer system occupies joints, fractures, and other secondary openings in bedrock, and pore spaces of overlying residual materials (Ref. 23, pp. 7, 9). The occurrence of water in the crystalline rock aquifer is controlled by these secondary openings. A well located approximately 2 miles from the site was reportedly drilled to a depth of 230 feet below land surface (bls) and cased to a depth of 46 feet bls (Ref. 23, p. 84) (Appendix A). The well yielded water at a rate of 40 gallons per minute (gpm). Depth to groundwater is highly variable dependent upon soil thickness and topographic expression (Ref. 23, p. 40). During the field investigation, groundwater was encountered as shallow as 4 feet below land surface and is often greater than 20 feet below land surface (Ref. 25). Groundwater flow in the Piedmont province is usually toward the streams and rivers, perpendicular to topographic contour lines and is thus quite variable in direction. Recharge into the aquifer occurs mainly through rainfall (Ref. 23, p. 9). The hydraulic conductivity for sediments similar to these is approximately 1.0×10^{-5} cm/sec (Ref. 24, p. 29).

3.3.2 Aquifer Use

The aquifer of concern within the study area is the unconfined crystalline rock aquifer. Although there are some portions of the study area supplied with municipal water (obtained from surface water sources), the majority of residents within the study area rely upon private wells for potable water (Refs. 25; 26; Appendix A). A breakdown of the number of residences that utilize wells for potable water in the study area (based on a 2.75 persons per household multiplier) is as follows: 102 (37 x 2.75) from 0 to 1 mile; 302 (110 x 2.75) from 1 to 2 miles; 544 (198 x 2.75) from 2 to 3 miles; and 605 (220 x 2.75) from 3 to 4 miles (Ref. 13, Appendix A). There are approximately 1,553 individuals within 4 miles of the power plant who rely upon private wells for potable water (Ref. 13, Appendix A). The nearest private well to the facility is located approximately 0.75 mile south (Appendix A).

4.0 FIELD INVESTIGATION

4.1 SAMPLE COLLECTION

During the field investigation, conducted September 16, 1990, FIT 4 attempted to identify and characterize contaminants which may be present in the environment as a result of activities that were conducted at Georgia Power - Wansley Steam Electric Generating Plant. To accomplish this, FIT 4 collected environmental surface soil, subsurface soil, groundwater, surface water, and sediment samples from a number of strategic locations. These locations were selected based on historical information, hydrogeological data for the region and site area, and direct observation at the site.

4.1.1 Sample Collection Methodology

All sample collection, sample preservation, and chain-of-custody procedures used during this investigation were in accordance with the standard operating procedures as specified in Sections 3 and 4 of the Environmental Compliance Branch Standard Operating Procedures and Quality Assurance Manual; U.S. Environmental Protection Agency, Region IV, Environmental Services Division, February 1, 1991.

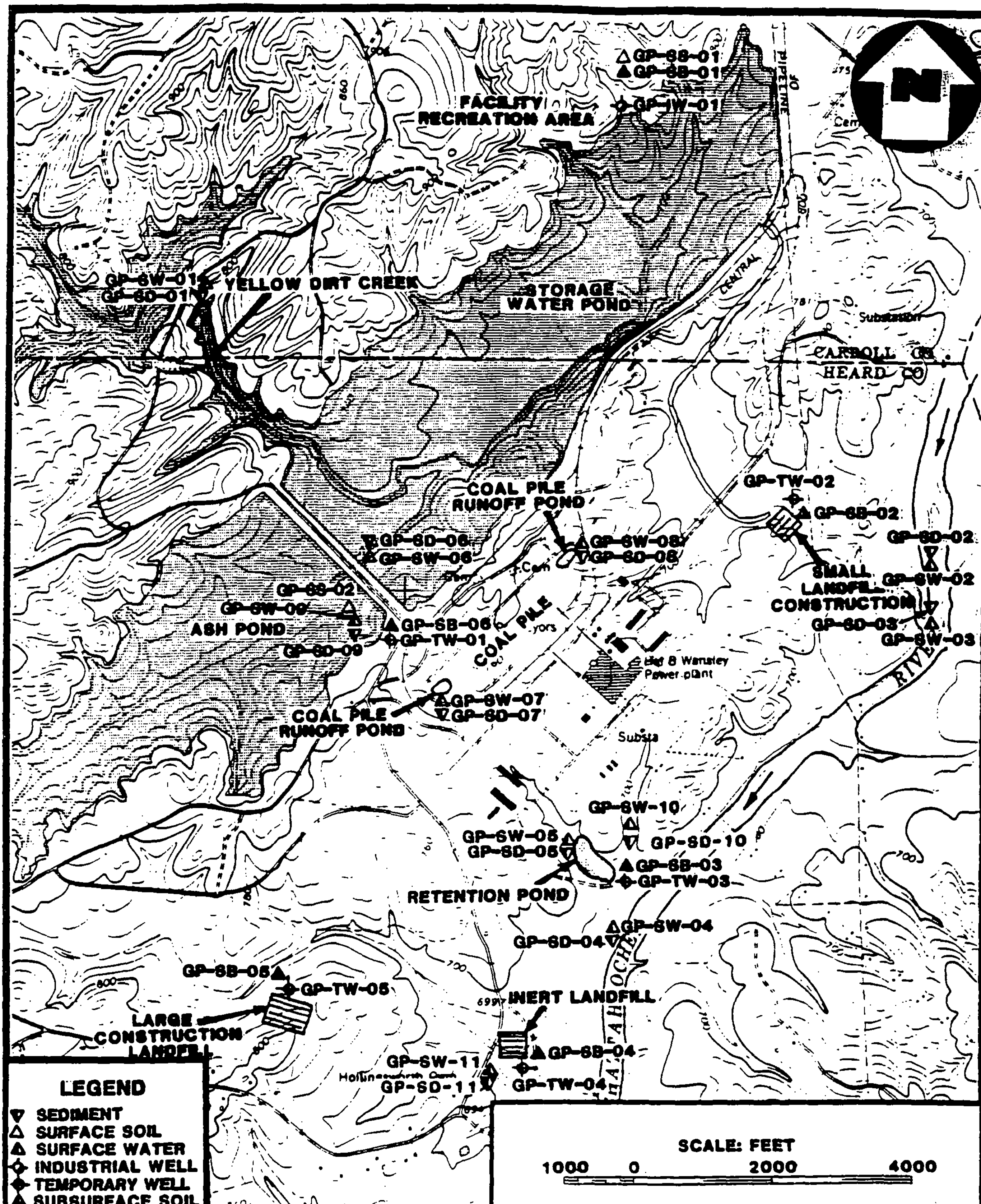
4.1.2 Duplicate Samples

Duplicate samples were offered to and accepted by Carolyn Kennedy and M.E. Sloop, designated representatives of Georgia Power - Wansley Steam Electric Generating Plant. Receipt for sample forms are on file at FIT 4.

4.1.3 Description of Samples and Sample Locations

During the sampling investigation, a total of 33 environmental samples were collected. All sample locations are shown in Figure 3. Sample codes, descriptions, locations, and rationale are contained in Table 1.

Surface soil samples were collected from two sampling points during the field investigation. The background surface soil sample GP-SS-01 was collected from the northern portion of the facility property at the employee recreation area (Figure 3) The other surface soil sample GP-SS-02 was collected from an ash delta that had formed in the easternmost corner of the Ash Pond (Figure 3).



SAMPLE LOCATION MAP
GEORGIA POWER - PLANT WANSLEY
ROOPVILLE, HEARD COUNTY, GEORGIA

FIGURE 3

NUS CORPORATION

TABLE 1

SAMPLE CODES, DESCRIPTIONS, LOCATIONS, AND RATIONALE
GEORGIA POWER WANSLEY STEAM ELECTRIC GENERATING PLANT
ROOPVILLE, HEARD COUNTY, GEORGIA

Sample Code	Sample Type	Location	Rationale
GP-SS-01	Surface Soil	Northern portion of the property, north of the Storage Water Pond at the Facility Recreation Area Campground	Background surface soil sample
GP-SS-02	Surface Soil	Located in the easternmost corner of the Ash Pond where ash has accumulated to the point of filling in portions of the pond	Ash sample
GP-SB-01	Subsurface Soil	Collected from the northeastern portion of the property, north of the Storage Water Pond at the Facility Recreation Area Campground (Collected at 5 feet blsd)	Background subsurface soil sample
GP-SB-02	Subsurface Soil	Collected from the northeastern corner of the Small Construction Landfill which is located northeast of the Power Plant main operational area (Collected 7 feet blsd)	To identify the presence or absence of subsurface soil contamination downgradient from the landfill
GP-SB-03	Subsurface Soil	Collected from the southern side of the facility Cooling Water Retention Pond which is located almost due south of the power plant (Collected at 3 feet blsd)	To identify the presence or absence of subsurface soil contamination
GP-SB-04	Subsurface Soil	Collected downgradient, due south of the Inert Landfill which is located south of the power plant (Collected 12 feet blsd)	To identify the presence or absence of subsurface soil contamination downgradient from the Inert Landfill
GP-SB-05	Subsurface Soil	Collected downgradient, south of the Large Construction Landfill which is located southwest of the power plant (Collected 10 feet blsd)	To identify the presence or absence of subsurface soil contamination downgradient from the Large Construction Landfill
GP-SB-06	Subsurface Soil	Collected adjacent to the easternmost corner of the Ash Pond (Collected at 7.5 feet blsd)	To determine the presence or absence of subsurface soil contamination

GP - Georgia Power
SS - Surface Soil
SB - Subsurface Soil
IW - Industrial Well (Groundwater)
TW - Temporary Well (Groundwater
SW - Surface Water
SD - Sediment
blsd - below land surface datum

TABLE 1

SAMPLE CODES, DESCRIPTIONS, LOCATIONS, AND RATIONALE
GEORGIA POWER WANSLEY STEAM ELECTRIC GENERATING PLANT
ROOPVILLE, HEARD COUNTY, GEORGIA

Sample Code	Sample Type	Location	Rationale
GP-IW-01	Groundwater	Collected from the facility well located at the Recreation Area (Total depth of well approximately 45 feet)	Background groundwater sample
GP-TW-01	Groundwater	Collected southeast and approximately 800 feet from the easternmost corner of the Ash Pond (Collected at 13 feet blsd)	To identify the presence or absence of contamination of groundwater near the Ash Pond
GP-TW-02	Not Collected		
GP-TW-03	Groundwater	Collected from the southern side of the facility cooling water Retention Pond which is located almost due south of the power plant (Collected 4 feet blsd)	To identify the presence or absence of groundwater contamination in this area
GP-TW-04	Groundwater	Collected downgradient, due south of the Inert Landfill which is located south of the power plant (Collected at 14 feet blsd)	To identify the presence or absence of groundwater contamination downgradient of the Inert Landfill
GP-SW-01	Surface Water	Collected upstream from the Storage Water Pond from Yellow Dirt Creek	Background surface water sample
GP-SW-02	Surface Water	Collected from the Chattahoochee River upstream from the facility at the power plant water intake (At the end of the boat ramp)	Control sample from the Chattahoochee River. For comparison with (GP-SW-04) facility waters entering the Chattahoochee River
GP-SW-03	Surface Water	Collected from the southern corner of the Storage Water Pond adjacent to the dike separating the Storage Water Pond and the Ash Pond	To identify the presence or absence of potential contaminants leaching through the containment dike from the Ash Pond into the Storage Water Pond
GP-SW-04	Surface Water	Collected from the confluence of the NPDES discharge and the Chattahoochee River	To identify the presence or absence of surface water contamination entering the Chattahoochee River from the facility

GP - Georgia Power
SS - Surface Soil
SB - Subsurface Soil
IW - Industrial Well (Groundwater)
TW - Temporary Well (Groundwater
SW - Surface Water
SD - Sediment
blsd - below land surface datum

TABLE 1

SAMPLE CODES, DESCRIPTIONS, LOCATIONS, AND RATIONALE
GEORGIA POWER WANSLEY STEAM ELECTRIC GENERATING PLANT
ROOPVILLE, HEARD COUNTY, GEORGIA

Sample Code	Sample Type	Location	Rationale
GP-SW-05	Surface Water	Collected from the facility Cooling Water Retention Pond south of the power plant	To identify the presence or absence of surface water contamination in the Retention Pond
GP-SW-06	Surface Water	Collected from the Coal Pile Run-off Pond located at the northeastern end of the Coal Pile	To identify the presence or absence of surface water contamination from the Coal Pile
GP-SW-07	Surface Water	Collected from the Coal Pile Run-off Pond located at the southeastern end of the Coal Pile	To identify the presence or absence of surface water contamination from the Coal Pile
GP-SW-08	Not Collected		
GP-SW-09	Surface Water	Collected from the easternmost corner of the Ash Pond	To identify the presence or absence of surface water contamination in the Ash Pond
GP-SW-10	Surface Water	Collected from a cooling water effluent drainage northeast of the Retention Pond	To identify the presence or absence of surface water contamination
GP-SW-11	Surface Water	Collected from a creek downslope of the Inert Landfill	To identify the presence or absence of surface water contamination
GP-SD-01	Sediment	Collected upstream from the Storage Water Pond from Yellow Dirt Creek	Background sediment sample
GP-SD-02	Sediment	Collected from the Chattahoochee River upstream from the facility at the power plant water intake (At the end of the boat ramp)	Control sample from the Chattahoochee River. For comparison with (GP-SD-04) facility waters entering the Chattahoochee River

GP - Georgia Power
SS - Surface Soil
SB - Subsurface Soil
IW - Industrial Well (Groundwater)
TW - Temporary Well (Groundwater
SW - Surface Water
SD - Sediment
blsd - below land surface datum

TABLE 1

SAMPLE CODES, DESCRIPTIONS, LOCATIONS, AND RATIONALE
GEORGIA POWER WANSLEY STEAM ELECTRIC GENERATING PLANT
ROOPVILLE, HEARD COUNTY, GEORGIA

Sample Code	Sample Type	Location	Rationale
GP-SD-03	Sediment	Collected from the southern corner of the Storage Water Pond adjacent to the dike separating the Storage Water Pond and the Ash Pond	To identify the presence or absence of potential contaminants leaching through the containment dike from the Ash Pond into the Storage Water Pond
GP-SD-04	Sediment	Collected from the confluence of the NPDES discharge and the Chattahoochee River	To identify the presence or absence of sediment contamination entering the Chattahoochee River from the facility
GP-SD-05	Sediment	Collected from the facility Cooling Water Retention Pond south of the power plant	To identify the presence or absence of sediment contamination in the Retention Pond
GP-SD-06	Sediment	Collected from the Coal Pile Run-off Pond located at the northeastern end of the Coal Pile	To identify the presence or absence of sediment contamination from the Coal Pile
GP-SD-07	Sediment	Collected from the Coal Pile Run-off Pond located at the southeastern end of the Coal Pile	To identify the presence or absence of sediment contamination from the Coal Pile
GP-SD-08	Sediment	Collected from a ditch that appeared to have once been routed from the Retention Pond southeast	To identify the presence or absence of contamination
GP-SD-09	Sediment	Collected from the southern corner of the Ash Pond	To identify the presence or absence of sediment contamination in the Ash Pond
GP-SD-10	Sediment	Collected from a cooling water effluent drainage northeast of the Retention Pond	To identify the presence or absence of sediment contamination

GP - Georgia Power
SS - Surface Soil
SB - Subsurface Soil
IW - Industrial Well (Groundwater)
TW - Temporary Well (Groundwater
SW - Surface Water
SD - Sediment
blsd - below land surface datum

TABLE 1

SAMPLE CODES, DESCRIPTIONS, LOCATIONS, AND RATIONALE
GEORGIA POWER WANSLEY STEAM ELECTRIC GENERATING PLANT
ROOPVILLE, HEARD COUNTY, GEORGIA

Sample Code	Sample Type	Location	Rationale
GP-SD-11	Sediment	Collected from a creek downslope of the Inert Landfill	To identify the presence or absence of sediment contamination

GP - Georgia Power
SS - Surface Soil
SB - Subsurface Soil
IW - Industrial Well (Groundwater)
TW - Temporary Well (Groundwater
SW - Surface Water
SD - Sediment
blsd - below land surface datum

Five subsurface soil samples were collected from the facility. The background subsurface soil sample was collected from the same location as background surface soil sample GP-SS-01, at the employee recreation area. A subsurface soil sample was collected from a downgradient location at each of the three facility landfills. Subsurface soil sample GP-SB-02 was collected downgradient (northeastern corner) from the Small Construction Landfill, sample GP-SB-04 was collected downgradient (south) from the Inert Landfill, and subsurface soil sample GP-SB-05 was collected downgradient (south) from the Large Construction Landfill (Figure 3). Subsurface soil sample GP-SB-03 was collected from the southern side of the facility retention pond, and the remaining subsurface soil sample GP-SB-06 was collected adjacent to the easternmost corner of the Ash Pond (Figure 3).

A total of four groundwater samples were collected during the investigation. The background groundwater sample GP-IW-01 was collected from a potable well located at the facility recreation area. Sample GP-TW-01 was collected downgradient from the Ash Pond. Another groundwater sample, GP-TW-03, was collected adjacent to the facility Retention Pond, whereas, the final groundwater sample, GP-TW-04, was collected downgradient from the Inert Landfill (Figure 3).

The background surface water sample GP-SW-01, was collected upstream from the Storage Water Pond in Yellow Dirt Creek (Figure 3). It was also necessary to collect a control sample, GP-SW-02, from an upstream location in the Chattahoochee River. This sample was collected upstream from the facility near the facility intake on the Chattahoochee River (Figure 3). Control sample GP-SW-02 was collected to compare with sample GP-SW-04 which was collected from the confluence of the facility NPDES effluent and the Chattahoochee River (Figure 3). The remaining seven surface water samples were collected from facility property to be compared to background sample GP-SW-01. The specific locations and rationale of these seven surface water samples are identified in Figure 3 and Table 1; however, a brief breakdown of these is as follows: Sample GP-SW-03 was collected from the Storage Water Pond, sample GP-SW-05 was collected from the Retention Pond, samples GP-SW-06 and GP-SW-07 were collected from run-off ponds that are located at each end of the Coal Pile, surface water sample GP-SW-09 was collected near the easternmost corner of the Ash Pond, sample GP-SW-10 was collected from a cooling water effluent drainage northeast of the Retention Pond, and surface water sample GP-SW-11 was collected from a creek downgradient of the Inert Landfill.

A total of eleven sediment samples were collected during the field investigation. As in the surface water samples, a background sediment sample GP-SD-01 was collected upstream from the Storage Water Pond in Yellow Dirt Creek (Figure 3). A control sample GP-SD-02 was collected from an upstream location in the Chattahoochee River. This sample was collected for comparison with GP-SD-04 which was collected from the confluence of the facility NPDES effluent and the Chattahoochee River (Figure 3). Except for sample GP-SD-08, all other sediment sampling locations are synonymous with surface water samples of the same numeric identifier. Sediment sample GP-SD-08 was collected that appears to have at one time drained the Retention Pond on the southwestern side of the Retention Pond (Figure 3).

4.1.4 Field Measurements

Field measurements were performed on all water samples (Table 2). Parameters measured included temperature, pH, and conductivity of the sample at time of collection. No field measurements were performed on the soil samples during this investigation.

4.2 SAMPLE ANALYSIS

4.2.1 Analytical Support and Methodology

All samples collected were analyzed under the Contract Laboratory Program (CLP) and analyzed for all organic and inorganic parameters listed in the Target Compound List (TCL). Organic analysis of soil and water samples was performed by Ecotek Laboratory Services, Inc. in Atlanta, Georgia. Inorganic analysis of soil and water samples was performed by Skinner and Sherman of Waltham, Massachussetts.

All laboratory analyses and laboratory quality assurance procedures used during this investigation were in accordance with standard procedures and protocols as specified in the Laboratory Operations and Quality Control Manual, U.S. Environmental Protection Agency (EPA), Region IV, Environmental Services Division, issued October 24, 1990; or as specified by the existing EPA standard procedures and protocols for the CLP Statement of Work, as applicable.

4.2.2 Analytical Data Quality and Data Qualifiers

All analytical data were subjected to a quality assurance review as described in the EPA Environmental Services Division laboratory data evaluation guidelines. In the tables, some of the concentrations of the organic and inorganic parameters have been flagged with a "J". This indicates that the qualitative analysis was acceptable, but the quantitative value has been estimated. A few other compounds are flagged with an "N", indicating that they were detected based on the presumptive evidence of their presence. This means that the compound was tentatively identified, and its detection cannot be used as positive identification of its presence. Results for some background samples are reported with a "U" flag. This flag means that the material was analyzed for but not detected. The reported number is the laboratory-derived minimum quantitation limit (MQL)

TABLE 2

FIELD MEASUREMENTS
GEORGIA POWER WANSLEY STEAM ELECTRIC GENERATING PLANT
ROOPVILLE, HEARD COUNTY, GEORGIA

Sample Code	Date (1990)	Time	pH	Temp. (°C)	Conductivity (umhos/cm)
GP-SW-01	9-17	1550	6.5	18	57
GP-SW-02	9-17	1740	6.3	24	107
GP-SW-03	9-20	0950	6.5	26	413
GP-SW-04	9-18	0950	7.6	29	377
GP-SW-05	9-18	1140	7.2	30	235
GP-SW-06	9-18	1645	4.5	28	469
GP-SW-07	9-18	1705	3.1	27	1111
GP-SW-08	Not Collected	-	-	-	-
GP-SW-09	9-20	0915	8.0	27	647
GP-SW-10	9-18	1220	7.1	30	126
GP-SW-11	9-18	1605	6.6	25	56
GP-IW-01	9-17	1640	6.4	21	55
GP-TW-01	9-19	1540	4.3	28	832
GP-TW-02	Not Collected	-	-	-	-
GP-TW-03	9-18	1120	5.8	25	261
GP-TW-04	9-18	1520	4.7	25	23

GP - Georgia Power
TW - Temporary Well
SW - Surface Water
IW - Industrial Well

for the compound or element in that sample. At times, miscellaneous organic compounds that do not appear on the target compound list are reported with a data set. These compounds are labeled as "JN", indicating that they are tentatively identified at estimated quantities. Because these compounds are not routinely analyzed for or reported, background levels or MQL values are not generally available for comparison. Groundwater and surface water sample results are compared to the national primary drinking water standard maximum contaminant levels (MCLs) for organic and inorganic analytes. The complete analytical data sheets are presented in Appendix B. It should be noted that trichlorotrifluorethane was reported in the soil trip blank, GP-TB-01S (50JN ug/kg).

4.2.3 Presentation of Analytical Results

This section presents a discussion and interpretation of the analytical results from the environmental samples collected during the investigation at Georgia Power - Wansley Steam Electric Generating Plant. Results of surface soil, subsurface soil, groundwater, surface water, and sediment samples are presented in Tables 3, 4, 5, 6, 7, 8, 9, 10, and 11. Background samples have been designated for all media. Values for background sample results are presented as either a measured value or as the MQL. Samples containing concentrations of contaminants greater than 3 times the background level or MQL of these contaminants are considered to be elevated. These samples are noted in the text.

4.2.3.1 Summary of Organic Analytical Results

Organic analytical results for samples collected at Georgia Power Plant Wansley are presented in Tables 3, 5, 7, and 9. No Target Compound List (TCL) organic compounds were reported in surface or subsurface soils samples. Trichlorotrifluorethane, a Tentatively Identified Compound (TIC), was detected in a subsurface soil sample collected from the inert landfill (GP-SB-04), the large construction landfill (GP-SB-05), and the ash pond (GP-SB-06). Of the nine sediment samples collected at the facility, three reported the presence of this purgeable organic. These were sediment samples from the storage water pond (GP-SD-03) and from the coal pile run-off pond (GP-SD-06, GP-SD-07). Trichlorotrifluorethane is a very volatile compound used as an organic degreasing solvent and also as an insulating fluid in transformers (Refs. 27, 28). The use of either halogenated solvents or PCB-substitutes in transformers at the facility could account for the presence of this compound in the soil samples.

When compared with sediment control sample GP-SD-02, both of the coal pile run-off pond samples (GP-SD-06, GS-SD-07) contained elevated concentrations of phenanthrene. Phenanthrene is a polynuclear aromatic compound (PNA). Members of this chemical family are normally found in fossil fuels. It is known that coal and/or oil are used as fuel at the facility. The presence of petroleum

TABLE 3

SUMMARY OF ORGANIC ANALYTICAL RESULTS
SOIL SAMPLES
GEORGIA POWER PLANT WANSLEY
ROOPVILLE, HEARD COUNTY, GEORGIA

PARAMETERS (ug/kg)	Soil Trip Blank GP-TB-01S	Background Surface Soil GP-SS-01	Ash Sample GP-SS-02	Background Subsurface Soil GP-SB-01	Small Construction Landfill GP-SB-02	Retention Pond GP-SB-03	Inert Landfill GP-SB-04	Large Construction Landfill GP-SB-05	Near Ash Pond GP-SB-06
PURGEABLE COMPOUNDS									
TRICHLOROTRIFLUOROETHANE(1)	50JN						80JN	70JN	100JN

Material analyzed for but not detected above minimum quantitation limit (MQL).
J Estimated value.
N Presumptive evidence of presence of material.
(1) Tentatively identified and unidentified compounds. This compound is not on Target Compound List and is reported only as detected in individual samples; MQL not determined.

TABLE 4

SUMMARY OF INORGANIC ANALYTICAL RESULTS
SOIL SAMPLES
GEORGIA POWER PLANT WANSLEY
ROOPVILLE, HEARD COUNTY, GEORGIA

PARAMETERS (mg/kg)	Background Surface Soil GP-SS-01	Ash Sample GP-SS-02	Background Subsurface Soil GP-SB-01	Small Construction Landfill GP-SB-02	Retention Pond GP-SB-03	Inert Landfill GP-SB-04	Large Construction Landfill GP-SB-05	Ash Pond GP-SB-06
ALUMINUM	22,000	11,000	23,000	15,000	15,000	26,000	8700	20,000
ANTIMONY	26J	-	32JN	-	-	-	-	18J
ARSENIC	2UJ	20J	2.1UJ	-	-	-	7.5J	3.4
BARIUM	83	110	81	73	250	86	31	120
BERYLLIUM	2U	1.5	2.9	-	-	-	-	-
CALCIUM	1400	11,000	100U	700	1800	-	1800	290
CHROMIUM	36J	33J	33J	8.6J	11J	12J	22J	34J
COBALT	17	3	51	12	42	2.9	-	30
COPPER	17J	-	33J	-	-	45J	-	34J
IRON	41,000	9800	53,000	28,000	29,000	23,000	22,000	37,000
LEAD	10UJ	21J	-	-	-	-	-	-
MAGNESIUM	3700	880	5800	3000	6200	2500	510	5400
MANGANESE	340	84	840	300	3400	79	67	500
NICKEL	11	13	14	5.8	7.4	-	2.6	21
POTASSIUM	3800	930	6000	2500	4600	2900	610	4600
THALLIUM	0.45U	2.1	-	-	-	-	-	-
VANADIUM	34	59	34	54	75	39	35	64
ZINC	74J	120J	150J	-	52J	-	-	61J

- Material analyzed for but not detected above minimum quantitation limit (MQL).
J Estimated value.
U Material was analyzed for but not detected. The number given is the MQL.

TABLE 5

SUMMARY OF ORGANIC ANALYTICAL RESULTS
SEDIMENT SAMPLES
GEORGIA POWER PLANT WANSLEY
ROOPVILLE, HEARD COUNTY, GEORGIA

	Background	Control	Storage Water Pond	NPDES/River Confluence	Retention Pond	Coal Pile Run-off Ponds		Retention Pond Ditch	Ash Pond
PARAMETERS (ug/kg)	GP-SD-01	GP-SD-02	GP-SD-03	GP-SD-04	GP-SD-05	GP-SD-06	GP-SD-07	GP-SD-08	GP-SD-09
PURGEABLE COMPOUNDS									
TRICHLOROTRIFLUOROETHANE(1)			50JN			200JN	100JN		
EXTRACTABLE COMPOUNDS									
NAPHTHALENE	690U	560U	-	-	-	340J	-	-	-
2-METHYLNAPHTHALENE	690U	560U	-	-	-	800	260J	-	160J
DIBENZOFURAN	690U	560U	-	-	-	350J	140J	-	83J
PHENANTHRENE	690U	120J	-	140J	-	1000	390J	-	270J
ANTHRACENE	690U	560U	-	-	-	160J	66J	-	55J
FLUORANTHENE	690U	240J	-	320J	-	-	-	-	-
PYRENE	690U	190J	-	280J	-	230J	70J	-	75J
BENZYL BUTYL PHTHALATE	690U	560U	-	78J	-	-	-	-	-
CHRYSENE	690U	110J	-	190J	-	130J	-	-	60J
BENZO(B AND/OR K)FLUORANTHENE	690U	110J	-	320J	-	-	-	-	-
BENZO-A-PYRENE	690U	560U	-	160J	-	-	-	-	-
HEXADECENOIC ACID(1)				900JN					
HEXADECANOIC ACID(1)				3000JN					

- Material analyzed for but not detected above minimum quantitation limit (MQL).
J Estimated value.
N Presumptive evidence of presence of material.
U Material was analyzed for but not detected. The number given is the MQL.
(1) Tentatively identified and unidentified compounds. This compound is not on Target Compound List and is reported only as detected in individual samples; MQL not determined.

TABLE 5

SUMMARY OF ORGANIC ANALYTICAL RESULTS
SEDIMENT SAMPLES
GEORGIA POWER PLANT WANSLEY
ROOPVILLE, HEARD COUNTY, GEORGIA

	Background	Control	Storage Water Pond	NPDES/River Confluence	Retention Pond	Coal Pile Run-off Ponds		Retention Pond Ditch	Ash Pond
PARAMETERS (ug/kg)	GP-SD-01	GP-SD-02	GP-SD-03	GP-SD-04	GP-SD-05	GP-SD-06	GP-SD-07	GP-SD-08	GP-SD-09
PETROLEUM PRODUCT(1)				N		N	N		N
DIMETHYLNAPHTHALENE(1)						2000JN/3	600JN/2		600JN/2
TRIMETHYLNAPHTHALENE(1)						800JN			200JN
ETHYLDIMETHYLAZULENE(1)						1000JN	400JN		400JN
UNIDENTIFIED COMPOUNDS(1)	5000J/4			5000J/3		10,000J/15	6000J/6	5000J/3	1000J/1
PESTICIDE\PCB COMPOUNDS									
DELTA-BHC	16U	13U	-	-	-	-	98	-	34
ENDOSULFAN SULFATE	32U	26U	-	-	-	140	85	-	21J

-    Material analyzed for but not detected above minimum quantitation limit (MQL).

J   Estimated value.

N   Presumptive evidence of presence of material.

U   Material was analyzed for but not detected. The number given is the MQL.

(1)   Tentatively identified and unidentified compounds. This compound is not on Target Compound List and is reported only as detected in individual samples; MQL not determined.

TABLE 6

SUMMARY OF INORGANIC ANALYTICAL RESULTS
SEDIMENT SAMPLES
GEORGIA POWER PLANT WANSLEY
ROOPVILLE, HEARD COUNTY, GEORGIA

PARAMETERS (mg/kg)	Background	Control	Storage Water Pond	NPDES/River Confluence	Retention Pond	Coal Pile Run-off Ponds		Retention Pond Ditch	Ash Pond
	GP-SD-01	GP-SD-02	GP-SD-03	GP-SD-04	GP-SD-05	GP-SD-06	GP-SD-07	GP-SD-08	GP-SD-09
ALUMINUM	12,000	9500	3800	17,000	19,000	3600	3200	17,000	13,000
ANTIMONY	9.3UR	7.9UR	-	-	-	-	-	30J	-
ARSENIC	2UJ	2UJ	-	6.2J	-	4.5J	4.5J	34J	-
BARIUM	60	87	13	140	110	51	28	140	170
CALCIUM	300U	480	210	1600	450	410	380	2100	6800
CHROMIUM	13J	16J	-	30J	14J	11J	14J	30J	43J
COBALT	3U	6.8	-	15	9.1	2.7	6.3	34	12
COPPER	20UJ	20UJ	-	34J	26J	21J	-	33J	28J
IRON	19,000	15,000	7800	27,000	34,000	15,000	12,000	32,000	20,000
LEAD	10UJ	20UJ	-	36J	-	-	-	-	28J
MAGNESIUM	1700	2700	390	3500	5800	1500	1000	5100	2900
MANGANESE	91	350	59	820	390	50	89	440	280
NICKEL	5.6	5.9	-	11	-	6.7	7.8	18	22
POTASSIUM	1400	2700	450	3300	1700	1500	1100	3700	3000
SELENIUM	0.72UR	0.55UR	-	1.8J	-	2.4J	1.5J	-	-
SILVER	1.5U	1.3U	3.5	-	-	-	-	-	-
THALLIUM	0.72U	0.55U	-	-	-	-	-	-	4.2
VANADIUM	16	23	2.5	59	76	24	20	67	88
ZINC	40UJ	82J	-	130J	130J	-	-	290J	150J

- Material analyzed for but not detected above minimum quantitation limit (MQL).
J Estimated value.
U Material was analyzed for but not detected. The number given is the MQL.
R Quality Control indicates that data is unusable. Compound may or may not be present.

TABLE 7

SUMMARY OF ORGANIC ANALYTICAL RESULTS
GROUNDWATER SAMPLES
GEORGIA POWER PLANT WANSLEY
ROOPVILLE, HEARD COUNTY, GEORGIA

PARAMETERS (ug/l)	Preservative Blank	Background	Downgradient		
			Ash Pond	Retention Pond	Inert Landfill
	GP-PB-01	GP-IW-01	GP-TW-01	*GP-TW-03	GP-TW-04
EXTRACTABLE COMPOUNDS					
OCTYLOXYBENZENE		10JN			
HEXANEDIOIC ACID, DIOCTYLESTER		90JN			
UNIDENTIFIED COMPOUNDS/NO.(1)		500J/16		40J/2	

J Estimated value.
N Presumptive evidence of presence of material.
(1) Tentatively identified and unidentified compounds. This compound is not on Target Compound List and is reported only as detected in individual samples; MQL not determined.
* GP-TW-02 not collected.

TABLE 8

SUMMARY OF INORGANIC ANALYTICAL RESULTS
GROUNDWATER SAMPLES
GEORGIA POWER PLANT WANSLEY
ROOPVILLE, HEARD COUNTY, GEORGIA

PARAMETERS (ug/l)	Preservative Blank	Background	Downgradient		
			Ash Pond	Retention Pond	Inert Landfill
	GP-PB-01	GP-IW-01	GP-TW-01	*GP-TW-03	GP-TW-04
ALUMINUM	-	30U	170,000	200,000	33,000
BARIUM	-	8U	380	630	120
BERYLLIUM	-	1U	17	10	1U
CALCIUM	-	4000	170,000	30,000	660U
CHROMIUM	-	6U	73	140	10
COBALT	-	4U	340	97	10
COPPER	-	3U	310	260	20U
IRON	-	170U	240,000	300,000	21,000
LEAD	-	4UJ	240J	-	20UJ
MAGNESIUM	-	880	15,000	47,000	4900
MANGANESE	-	20U	14,000	2900	160
NICKEL	-	6U	120	46	8U
POTASSIUM	-	1400U	21,000	31000	4400
SODIUM	-	3000UJ	34,000J	20,000J	2800UJ
VANADIUM	-	3U	580	760	39
ZINC	-	810	390	430	70U

- Material analyzed for but not detected above minimum quantitation limit (MQL).

J Estimated value.

U Material was analyzed for but not detected. The number given is the MQL.

* GP-TW-02 not collected.

TABLE 9

SUMMARY OF ORGANIC ANALYTICAL RESULTS
SURFACE WATER SAMPLES
GEORGIA POWER PLANT WANSLEY
ROOPVILLE, HEARD COUNTY, GEORGIA

	Background	Control	Storage Water Pond	NPDES/River Confluence	Retention Pond	Coal Pile Run-off Ponds		Ash Pond	Cooling Water Effluent	Inert Landfill
PARAMETERS (ug/l)	GP-SW-01	GP-SW-02	GP-SW-03	GP-SW-04	GP-SW-05	GP-SW-06	*GP-SW-07	GP-SW-09	GP-SW-10	GP-SW-11
EXTRACTABLE COMPOUNDS										
UNIDENTIFIED COMPOUNDS/NO (1)							60J/2			

J Estimated value.

(1) Tentatively identified and unidentified compounds. This compound is not on Target Compound List and is reported only as detected in individual samples; MQL not determined.

* GP-SW-08 not collected.

TABLE 10

SUMMARY OF INORGANIC ANALYTICAL RESULTS
SURFACE WATER SAMPLES
GEORGIA POWER PLANT WANSLEY
ROOPVILLE, HEARD COUNTY, GEORGIA

	Background	Control	Storage Water Pond	NPDES/River Confluence	Retention Pond	Coal Pile Run-off Ponds		Ash Pond	Cooling Water Effluent	Inert Landfill
PARAMETERS (ug/l)	GP-SW-01	GP-SW-02	GP-SW-03	GP-SW-04	GP-SW-05	GP-SW-06	*GP-SW-07	GP-SW-09	GP-SW-10	GP-SW-11
ALUMINUM	180U	3700	-	2100	850	8100	1900	2700	-	-
BARIUM	9U	-	-	62	52	-	69	160	-	-
CALCIUM	1600U	8100	3500	42,000	36,000	62,000	38,000	120,000	7500	2500
CHROMIUM	6U	-	-	9	-	-	-	27	-	-
COBALT	4U	-	-	-	-	170	160	-	-	-
IRON	620U	3400	-	3700	2600	8000	-	1600	3300	-
MAGNESIUM	880	1600	1100	2600	2500	13,000	9300	2100	2600	1000
MANGANESE	17	110	-	240	200	3900	6200	42	300	25
NICKEL	6U	-	-	-	-	100	24	-	9	-
POTASSIUM	1200U	2800	-	5100	4900	4700	7400	6700	4400	-
SELENIUM	2UJ	-	-	-	11J	-	-	15J	-	-
SODIUM	2300UJ	-	-	13,000J	12,000J	43,000J	20,000J	25,000J	-	-
VANADIUM	3U	10	-	30	23	-	-	60	-	-
ZINC	20U	-	-	-	-	580	-	-	-	-

- Material analyzed for but not detected above minimum quantitation limit (MQL).

J Estimated value.

U Material was analyzed for but not detected. The number given is the MQL.

* GP-SW-08 not collected.

product was reported in the coal pile run-off pond samples, the NPDES/river confluence sample (GP-SD-04), and the ash pond sediment sample (GP-SD-09). Other PNA compounds were tentatively identified in the run-off pond samples and the ash pond sample. Two pesticides were reported at elevated levels in the coal pile run-off pond sediment samples. Delta-BHC was detected in sediment sample GP-SD-07 (98 ug/kg, 7 times control). Endosulfan sulfate was detected in sample GP-SD-06 (140 ug/kg, 5 times control) and GP-SD-07 (85 ug/kg, 3 times control). The presence of these pesticides in the pond sediment may be due to spraying around the pond or drainage of surface water run-off from areas where spraying occurred.

No TCL organic compounds were reported in groundwater or surface water samples collected at the facility.

4.2.3.2 Summary of Inorganic Analytical Results

The principle components of coal ash, after the oxidation of carbon and its compounds, are metals, many of which are toxic; therefore, the results of inorganic analyses are important for the site. Inorganic analytical results for Georgia Power Plant Wansley are presented in Tables 4, 6, 8, and 10. Arsenic (20J mg/kg, 10 times MQL), calcium (11,000 mg/kg, 7 times background), and thallium (2.1 mg/kg, 4 times MQL) were detected in surface soil sample GP- SS-02, which was collected from the ash pile. Three subsurface soil samples, GP-SB-02 from the small construction landfill, GP-SB-03 from the cooling water retention pond, and GP-SB-05 from the large construction landfill, contained elevated concentrations of calcium. Barium (250 mg/kg, 3 times background) and manganese (3,400 mg/kg, 4 times background) were detected in subsurface soil sample collected from the cooling water retention pond. Subsurface soil from the large construction landfill contained arsenic at a concentration of 7.5J mg/kg (3 times MQL).

Groundwater at the plant contained high levels of many inorganic constituents. GP-IW-01, collected from a potable water well at an approximate depth of 45 feet, was designated as background for the groundwater samples. In some cases, results for onsite groundwater samples, collected from shallow temporary wells, were elevated thousands of times above background. It was decided to use the groundwater sample from the inert landfill (GP-TW-04) as an onsite control sample. The groundwater sample from near the Ash Pond (GP-TW-01) reported 16 inorganic analytes at elevated levels ranging from three to 257 times control. Notable among these were chromium (73 ug/l, 7 times control) and lead (240J ug/l, 12 times MQL). The groundwater sample (GP-TW-03) collected near the cooling water retention pond contained 15 inorganic constituents at elevated levels ranging from 5 to 45 times control, including chromium (140 ug/l, 14 times control). Maximum Contaminant Levels (MCLs) for drinking water, as mandated by the federal government, were exceeded in groundwater samples for the following metals (the values following analytes are (MCL Values) (Maximum Concentration identified in groundwater from this investigation): beryllium (1 ug/l) (17 ug/l), chromium (50 ug/l) (140 ug/l), lead (15 ug/l) (240J ug/l), nickel (100 ug/l) (120 ug/l). Secondary Maximum Contaminant Levels (SMCLs) were also exceeded for aluminum (50 - 200 ug/l) (200,000 ug/l), iron (300 ug/l) (300,000 ug/l), manganese (50 ug/l) (14,000 ug/l) (Ref. 29, 30, 31).

Sediment sample GP-SD-04, collected from the confluence of the NPDES discharge and Chattahoochee River, contained seven metals at elevated concentrations ranging from 3 to 9 times background sample GP-SD-01. These metals were arsenic (6.2J mg/kg, 3 times MQL), calcium, cobalt, lead (36J mg/kg, 3 times MQL), manganese, vanadium, and zinc. Cobalt, magnesium, manganese, vanadium, and zinc were elevated in the cooling water retention pond sediment sample (GP-SD-06). Sediment samples collected from the coal pile run-off pond contained only one elevated inorganic constituent. Selenium (2.4J mg/kg, 3 times MQL) was reported in sample GP-SD-06. Sample GP-SD-08, from a ditch that may have drained the retention pond, contained nine elevated metals. These were antimony, arsenic (34J mg/kg, 17 times MQL), calcium, cobalt, magnesium, manganese, nickel, vanadium, and zinc. This ditch appears to have drained south-southwest from the Retention Pond. Sediment from the ash pond, sample GP-SD-09, contained eight elevated metals, including chromium (43J mg/kg, 3 times background).

Surface water samples collected from the storage water pond (GP-SW-03) and the inert landfill (GP-SW-11) contained no inorganic analytes at elevated concentrations. The other six onsite surface water samples collected from the confluence of the NPDES stream and the Chattahoochee River (GP-SW- 04), the cooling water retention pond (GP-SW-05), the coal pile run-off pond (GP-SW-06, GP-SW-07), the ash pond (GP-SW-09), and cooling water effluent (GP- SW-10) contained a host of inorganic constituents at elevated concentrations. The following eight metals were detected at elevated levels in at least three of the six samples: aluminum, barium, calcium, iron, manganese, potassium, sodium, and vanadium. The federally mandated MCL for nickel in drinking water is 100 ug/l. This quantity was reported in sample GP-SW-06. The MCL for selenium is 10 ug/l. Sample GP-SW-05, collected from the retention pond, contained selenium at a concentration of 11J, while sample GP-SW-09, collected from the ash pond contained 15J ug/l of selenium. SMCLs for aluminum (50 - 200 ug/l), iron (300 ug/l), and manganese (50 ug/l) were exceeded many times over in the surface water samples (Refs. C, D). The NPDES discharge sample (GP-SW-04) exceeded all three of these SMCLs.

Coal ash consists primarily of silicon, aluminum, iron, and calcium (Ref. 32). The latter three, which are part of routine CLP analyses, were detected at elevated concentrations in many of the environmental samples collected at Georgia Power Plant Wansley. Magnesium, potassium, sodium, and titanium are the next largest group of metals found in coal ash (Ref. 32). Again, magnesium, potassium, and sodium were found in abundance, especially in groundwater and surface water samples. Finally, eastern and midwestern coals, as opposed to western coals, show higher proportions of arsenic, selenium, chromium, and vanadium (Ref. 32). All four of these metals were repeatedly reported in the samples. According to the analytical data, toxic metals of special concern at the power plant are arsenic, barium, beryllium, chromium, lead, manganese, nickel, selenium, and zinc. It is expected to find high levels of inorganics at coal-burning power plants. The issue is containment of these toxic metals. Sediment, surface water and ground water results indicate a potential for posing an environmental threat.

5.0 SUMMARY

The groundwater pathway is of primary concern at Georgia Power. The unconfined crystalline rock aquifer is the aquifer of concern in the study area. Approximately 1,553 residents in the study area obtain water from private wells completed in this aquifer. The surface water pathway is also of concern because recreational boating and fishing are common activities in waters onsite (except for the Ash Pond and effluent) and downstream. The onsite exposure pathway is a concern due to the number of employees (approximately 325) working at the facility. The air exposure pathway is of limited concern due to the facility's rural setting.

The sampling investigation consisted of the collection of 33 environmental samples: two surface soil samples, six subsurface soil samples, four groundwater samples, ten surface water samples, and eleven sediment samples.

Organic analysis identified presumptive evidence of the presence of Trichlorotrifluoroethane in estimated concentrations in subsurface soils and sediments throughout much of the study area. Trichlorotrifluoroethane is a volatile compound that is commonly used as a degreasing solvent and an insulating fluid in transformers. Polynuclear aromatic compounds (PNAs) were identified (presumptive and estimated) in sediment samples collected from the two Coal Pile Run-off Ponds as well as the Ash Pond. These may be attributable to creosote from nearby railroad tracks or the coal. Presumptive evidence of petroleum product was also indicated in sediment samples. Also, elevated levels of pesticides were identified in sediment samples collected from the Coal Pile Run-off Ponds as well as in the Ash Pond.

Inorganic analytes were identified as elevated in surface soils, subsurface soils, groundwater, surface water, and sediment samples. Since the groundwater and surface water pathways are of the greatest concern in this investigation the most notable findings were identified in groundwater and surface water samples. Chromium (7 times control) and lead (12 times control) were detected in the groundwater sample collected near the Ash Pond. Chromium (14 times control) was also detected in a groundwater sample collected near the Cooling Water Retention Pond. Some of the groundwater samples collected during the field investigation exceeded the Maximum Contaminant Levels (MCLs) for primary drinking water standards for chromium, lead, and nickel.

Some of the surface water samples collected contained elevated levels of aluminum, barium, calcium, iron, manganese, potassium, sodium, and vanadium. Maximum Contamination Levels (MCLs) for primary drinking water standards were reached or exceeded for nickel and selenium.

Considering the number of groundwater targets in the area as well as surface water and onsite exposure targets, it is recommended that this facility be evaluated using the HRS (effective March 14, 1991).

REFERENCES

1. HALLIBURTON NUS Environmental Corporation Field Logbook No. F4-2500 for Georgia Power Plant Wansley, TDD No. F4-8909-62. Documentation of on site facility reconnaissance, August 23, 1990.

2. Potential Hazardous Waste Site Preliminary Assessment (EPA Form 2070-12), and attachments for Georgia Power Company Wansley Steam Electric Generating Station. Filed by Steve Walker, Georgia Department of Natural Resources, August 21, 1985.

3. EPA Hazardous Waste Permit Application (EPA Form 3510-1) for Georgia Power Wansley Steam Electric Generating Station, Roopville, Heard County, Georgia. Filed by W.E. Ehrensperger, Sr. V.P., Power Supply, November 18, 1980.

4. John D. Taylor, Program Manager, Georgia Department of Natural Resources Industrial & Hazardous Waste Management Program, letter to D.N. MacLemore, V.P. and Chief Engineer, Georgia Power Supply Engineering and Services. August 15, 1983. Subject: Withdrawal of application for a Hazardous Waste facility permit.

5. U.S. Environmental Protection Agency, Facility Hazardous Waste Report (HWR07A), Facility status as of January 5, 1988.

6. Georgia Environmental Protection Division, Georgia Annual Hazardous Waste Report, Reporting Period January 1, 1983 through December 31, 1983. Submitted by T.E. Byerley, Georgia Power Manager of Environmental Affairs for Georgia Power Company Plant Wansley, March 22, 1984.

7. Margaret Markey, Georgia Department of Natural Resources, Trip Report for Georgia Power Plant Wansley. Dated December 3, 1982.

8. Karl S. Vorres, "Coal", Kirk-Othmer Encyclopedia of Chemical Technology, 3rd ed., Vol. 6 (New York: John Wiley & Sons, 1979).

9. Stephen P. Ellis, Southern Company Services, letter and attachments to Gary F. Brendel, GAI Consultants, June 5, 1986. Subject: Ash analysis.

10. William Salter, Inspector, Georgia Department of Natural Resources, Trip Report and Generator Standards Checklist (state of Georgia Form HW-0038F). Dated May 19, 1989.

11. National Archives and Records Administration, Code of Federal Regulations, Protection of Environment 40: Parts 190 to 299, Revised July 1, 1988 (Washington, D.C.: GPO, 1988).

12. Georgia Environmental Protection Division, Georgia Biennial Hazardous Waste Report. Reporting Period January 1, 1987 through December 31, 1987. Submitted by W.C. Sewell, Plant Manager, Georgia Power Plant Wansley, February 22, 1988.

13. U.S. Department of Commerce, Proof Copy of table generated for 1990 CPH-1: Summary Population and Housing Characteristics, issued by Bureau of the Census (April 1991).

14. U.S. Environmental Protection Agency, Graphical Exposure Modeling System (GEMS) Data Base, compiled from U.S. Bureau of the Census Data (1980).

15. U.S. Department of Agriculture, Soil Conservation Service, Soil Survey of Carroll and Haralson Counties, Georgia, (March 1971).

16. U.S. Fish and Wildlife Service, Endangered and Threatened Species of the Southeastern United States, (Atlanta, Georgia 1988).

17. U.S. Department of Commerce, Climatic Atlas of the United States (Washington, D.C.: GPO, June 1968) Reprint 1983, National Oceanic and Atmospheric Administration, pp. 43, 63.

18. U.S. Department of Commerce, Rainfall Frequency Atlas of the United States, Technical Paper No. 40 (Washington, D.C.: GPO, 1961), p. 93.

19. Tammy Barr, City of Franklin Water Department, telephone conversation with John Jenkins, HALLIBURTON NUS Environmental Corporation, September 9, 1991. Subject: Water Intakes along the Chattahoochee River.

20. Walt Williams, Superintendent, City of LaGrange Water Department, telephone conversation with John Jenkins, HALLIBURTON NUS Environmental Corporation, September 16, 1991. Subject: Water intakes and recreational use of the Chattahoochee River.

21. Keith I. McConnell and Charlotte E. Abrams, Geology of the Greater Atlanta Region, Georgia Geologic Survey Bulletin No. 96 (Atlanta, Georgia, 1984).

22. Linda Aller, et al., DRASTIC: A Standardized System For Evaluating Ground Water Pollution Potential Using Hydrologic Settings, EPA-600/2-87-035 (Ada, Oklahoma: EPA, April 1987).

23. C.W. Cressler, et al, Ground Water in the Greater Atlanta Region, Georgia, Georgia Geologic Survey Information Circular No. 63 (Atlanta, Georgia, 1983).

24. R. Allan Freeze and John A. Cherry, Groundwater (Englewood Cliffs, N.J.: Prentice-Hall, Inc., 1979), p. 29.

25. Jim Baxley, Manager, Carroll County Water System, telephone conversation with Maureen Gordon, NUS Corporation, October 11, 1989. Subject: Municipal water sources and distribution lines in the area of Georgia Power Plant Wansley.

26. HALLIBURTON NUS Environmental Corporation Field Logbook No. F4-2959 for Georgia Power Plant Wansley, TDD No. F4-8909-62. Documentation of field activities September 17-20, 1990.

27. Frederick A. Lowenheim, "Electroplating," Kirk-Othmer Encyclopedia of Chemical Technology, 3rd Ed., Vol. 8 (New York: John Wiley and Sons, 1979).

28. R. N. Sampson, "Insulation, Electric, Properties and Material," Kirk-Othmer Encyclopedia of Chemical Technology, 3rd Ed., Vol. 13 (New York: John Wiley and Sons, 1981).

29. U.S. Environmental Protection Agency, Office of Drinking Water, Drinking Water Regulations and Health Advisories, (Washington, D.C.: November 1990).

30. U.S. Environmental Protection Agency, Office of Drinking Water, Phase II Fact Sheet: National Primary Drinking Water Regulations for 38 Inorganic and Synthetic Organic Chemicals (Washington, D.C.: January 1991).

31. Glenn Adams, Groundwater Technology Unit, USEPA, Atlanta, Georgia, telephone conversation with Joan Dupont, HALLIBURTON NUS Environmental Corporation, July 15, 1991. Subject: Federal standard for lead in drinking water.

32. Wastes from the Combustion of Coal by Electric Utility Power Plants, Report to Congress, USEPA/530-SW-88-0022 (Washington, D.C.: Office of Solid Waste, February 1988).

REFERENCE 7

PRELIMINARY ASSESSMENT COVER SHEET
GA POWER CO. WANSLEY STM. ELEC. GEN. STA.
GAD000612937

The Georgia Power Company Wansley Steam Electric Generating Station has been in operation since 1976 at its present location. The RCRA Part A Application permit filed by the facility indicates joint ownership between Georgia Power, Oglethorpe Power Corp., The Municipal Electric Authority of Georgia, and the City of Dalton, Georgia. The facility is operated by the Georgia Power Company. The facility generates electricity by burning coal and/or oil to boil large tanks of water. The steam generated from the boiling water is used to turn turbines which generate electricity. Waste ash is disposed of in an ash pond (See attached map). The boilers are cleaned periodically to remove copper and iron scale. This results in the generation of several thousand gallons of waste wash water, most of which is placed in the ash pond. This boiler cleaning waste was granted an exclusion from the Georgia Rules for Hazardous Waste Management in 1983. The facility discharges some of the liquid wastes generated on site under NPDES permit GA0024778.

The site is located in a sparsely inhabited portion of Heard and Carroll Counties. Surface runoff from the site enters the Chattahoochee River about 1/2 mile east of the site. Porosity and permeability of rocks underlying the site are largely the result of fractures and joints within the rock units or the result of a contact between 2 or more different rock types.

The Waste Management Data Sheet dated 3/22/84 (attached) indicated that it has generated PCB's, organics and inorganics and that no information exists as to the disposal practices of these substances prior to 1980. For this reason, the site is assessed a "LOW" priority for a Site Inspection. Since 1980, all hazardous wastes generated at the site have been handled in accordance with the Georgia Rules for Hazardous Waste Management.

CSW/mcw016

EPA

POTENTIAL HAZARDOUS WASTE SITE PRELIMINARY ASSESSMENT
PART 1 - SITE INFORMATION AND ASSESSMENT

I. IDENTIFICATION
01 STATE: GA | 02 SITE NUMBER: D000612937

II. SITE NAME AND LOCATION

01 SITE NAME (Legal, common, or descriptive name of site): GA Power Co. Wansley Stm. Elec. Gen. Stal

02 STREET, ROUTE NO., OR SPECIFIC LOCATION IDENTIFIER: P. O. Box 214, GA Hwy. 5

03 CITY	04 STATE	05 ZIP CODE	06 COUNTY	07 COUNTY CODE	08 CONG DIST
Roopville	GA	30170	Heard	149	06

09 COORDINATES LATITUDE: 33° 24' 45.0" LONGITUDE: 085° 03' 00.0"

10 DIRECTIONS TO SITE (Starting from nearest public road):
From Glenlock community proceed east on Friendship Chruch Road. Ash pond is on the left (north) side of the road about 1 mile from Glenlock.

III. RESPONSIBLE PARTIES

01 OWNER (if known): See PA Cover Sheet and RCRA Part A
02 STREET (Business, mailing, residential):
03 CITY: Application (attached)
04 STATE: 05 ZIP CODE: 06 TELEPHONE NUMBER: ( )

07 OPERATOR (if known and different from owner): Georgia Power Company
08 STREET (Business, mailing, residential): P. O. Box 4545
09 CITY: Atlanta
10 STATE: GA 11 ZIP CODE: 30302 12 TELEPHONE NUMBER: (404) 522-6060

13 TYPE OF OWNERSHIP (Check one)
☐ A. PRIVATE ☐ B. FEDERAL: ____ (Agency name) ☐ C. STATE ☐ D. COUNTY ☐ E. MUNICIPAL
☒ F. OTHER: private and municipal joint ownership (Specify) ☐ G. UNKNOWN

14 OWNER/OPERATOR NOTIFICATION ON FILE (Check all that apply)
☒ A. RCRA 3001 DATE RECEIVED: / / (MONTH DAY YEAR) ☐ B. UNCONTROLLED WASTE SITE (CERCLA 103 c) DATE RECEIVED: / / (MONTH DAY YEAR) ☐ C. NONE

IV. CHARACTERIZATION OF POTENTIAL HAZARD

01 ON SITE INSPECTION
☐ YES ☒ NO DATE / / (MONTH DAY YEAR)
BY (Check all that apply)
☐ A. EPA ☐ B. EPA CONTRACTOR ☐ C. STATE ☐ D. OTHER CONTRACTOR
☐ E. LOCAL HEALTH OFFICIAL ☐ F. OTHER: ____ (Specify)
CONTRACTOR NAME(S):

02 SITE STATUS (Check one)
☒ A. ACTIVE ☐ B. INACTIVE ☐ C. UNKNOWN

03 YEARS OF OPERATION: 1976 (BEGINNING YEAR) | continuing (ENDING YEAR) ☐ UNKNOWN

04 DESCRIPTION OF SUBSTANCES POSSIBLY PRESENT, KNOWN, OR ALLEGED
PCB's, solvents

05 DESCRIPTION OF POTENTIAL HAZARD TO ENVIRONMENT AND/OR POPULATION
Low - little information exists regarding hazardous waste disposal practices prior to 1980.

V. PRIORITY ASSESSMENT

01 PRIORITY FOR INSPECTION (Check one. If high or medium is checked, complete Part 2 - Waste Information and Part 3 - Description of Hazardous Conditions and Incidents)
☐ A. HIGH (Inspection required promptly) ☐ B. MEDIUM (Inspection required) ☒ C. LOW (Inspect on time available basis) ☐ D. NONE (No further action needed, complete current disposition form)

VI. INFORMATION AVAILABLE FROM

01 CONTACT	02 OF (Agency/Organization)	03 TELEPHONE NUMBER
Mr. Bob Woodall-Man. Env. Affairs	Georgia Power Company	(404) 526-7108

04 PERSON RESPONSIBLE FOR ASSESSMENT	05 AGENCY	06 ORGANIZATION	07 TELEPHONE NUMBER	08 DATE
Steve Walker	DNR	EPD-RAU	(404) 656-7404	08 21 85 (MONTH DAY YEAR)

EPA FORM 2070-12 (7-81)

J. Jurovic

EPA

POTENTIAL HAZARDOUS WASTE SITE PRELIMINARY ASSESSMENT
PART 2 - WASTE INFORMATION

I. IDENTIFICATION

01 STATE	02 SITE NUMBER
GA	D000612937

II. WASTE STATES, QUANTITIES, AND CHARACTERISTICS

01 PHYSICAL STATES (Check all that apply)

- ☐ A. SOLID
- ☐ B. POWDER FINES
- ☐ C. SLUDGE
- ☐ D. OTHER ________ (Specify)
- ☐ E. SLURRY
- X F. LIQUID
- ☐ G. GAS

02 WASTE QUANTITY AT SITE (Measures of waste quantities must be independent)

TONS ________

CUBIC YARDS unknown

NO. OF DRUMS ________

03 WASTE CHARACTERISTICS (Check all that apply)

- X A. TOXIC
- ☐ B. CORROSIVE
- ☐ C. RADIOACTIVE
- ☐ D. PERSISTENT
- ☐ E. SOLUBLE
- ☐ F. INFECTIOUS
- ☐ G. FLAMMABLE
- ☐ H. IGNITABLE
- ☐ I. HIGHLY VOLATILE
- ☐ J. EXPLOSIVE
- ☐ K. REACTIVE
- ☐ L. INCOMPATIBLE
- ☐ M. NOT APPLICABLE

III. WASTE TYPE

CATEGORY	SUBSTANCE NAME	01 GROSS AMOUNT	02 UNIT OF MEASURE	03 COMMENTS
SLU	SLUDGE			
OLW	OILY WASTE			
SOL	SOLVENTS	unknown	-----	various organic and inorganic
PSD	PESTICIDES			
OCC	OTHER ORGANIC CHEMICALS			
IOC	INORGANIC CHEMICALS			
ACD	ACIDS			
BAS	BASES			
MES	HEAVY METALS			

IV. HAZARDOUS SUBSTANCES (See Appendix for most frequently cited CAS Numbers)

01 CATEGORY	02 SUBSTANCE NAME	03 CAS NUMBER	04 STORAGE/DISPOSAL METHOD	05 CONCENTRATION	06 MEASURE OF CONCENTRATION

V. FEEDSTOCKS (See Appendix for CAS Numbers)

CATEGORY	01 FEEDSTOCK NAME	02 CAS NUMBER	CATEGORY	01 FEEDSTOCK NAME	02 CAS NUMBER
FDS			FDS		
FDS			FDS		
FDS			FDS		
FDS			FDS		

VI. SOURCES OF INFORMATION (Cite specific references, e.g., state files, sample analysis, reports)

GA EPD State Files.

EPA

POTENTIAL HAZARDOUS WASTE SITE
PRELIMINARY ASSESSMENT
PART 3 - DESCRIPTION OF HAZARDOUS CONDITIONS AND INCIDENTS

I. IDENTIFICATION

01 STATE	02 SITE NUMBER
GA	D000612937

II. HAZARDOUS CONDITIONS AND INCIDENTS

01 [X] A. GROUNDWATER CONTAMINATION — 02 ☐ OBSERVED (DATE: ______) — [X] POTENTIAL — ☐ ALLEGED
03 POPULATION POTENTIALLY AFFECTED: unknown
04 NARRATIVE DESCRIPTION
Potential if solvents were released into ash pond which was used to hold non-hazardous fly ash and non-hazardous boiler cleaning waste.

01 [X] B. SURFACE WATER CONTAMINATION — 02 ☐ OBSERVED (DATE ______) — [X] POTENTIAL — ☐ ALLEGED
03 POPULATION POTENTIALLY AFFECTED: unknown
04 NARRATIVE DESCRIPTION
Potential if solvents were released into ash pond which was used to hold non-hazardous fly ash and non-hazardous boiler cleaning waste.

01 ☐ C. CONTAMINATION OF AIR — 02 ☐ OBSERVED (DATE ______) — ☐ POTENTIAL — ☐ ALLEGED
03 POPULATION POTENTIALLY AFFECTED: ______
04 NARRATIVE DESCRIPTION

01 ☐ D. FIRE/EXPLOSIVE CONDITIONS — 02 ☐ OBSERVED (DATE ______) — ☐ POTENTIAL — ☐ ALLEGED
03 POPULATION POTENTIALLY AFFECTED: ______
04 NARRATIVE DESCRIPTION

01 ☐ E. DIRECT CONTACT — 02 ☐ OBSERVED (DATE ______) — ☐ POTENTIAL — ☐ ALLEGED
03 POPULATION POTENTIALLY AFFECTED: ______
04 NARRATIVE DESCRIPTION

01 [X] F. CONTAMINATION OF SOIL — 02 ☐ OBSERVED (DATE ______) — [X] POTENTIAL — ☐ ALLEGED
03 AREA POTENTIALLY AFFECTED: unknown
04 NARRATIVE DESCRIPTION
Potential if solvents or PCB's were released on site.

01 ☐ G. DRINKING WATER CONTAMINATION — 02 ☐ OBSERVED (DATE ______) — ☐ POTENTIAL — ☐ ALLEGED
03 POPULATION POTENTIALLY AFFECTED: ______
04 NARRATIVE DESCRIPTION

01 ☐ H. WORKER EXPOSURE/INJURY — 02 ☐ OBSERVED (DATE ______) — ☐ POTENTIAL — ☐ ALLEGED
03 WORKERS POTENTIALLY AFFECTED: ______
04 NARRATIVE DESCRIPTION

01 ☐ I. POPULATION EXPOSURE/INJURY — 02 ☐ OBSERVED (DATE ______) — ☐ POTENTIAL — ☐ ALLEGED
03 POPULATION POTENTIALLY AFFECTED: ______
04 NARRATIVE DESCRIPTION

EPA

POTENTIAL HAZARDOUS WASTE SITE PRELIMINARY ASSESSMENT
PART 3 - DESCRIPTION OF HAZARDOUS CONDITIONS AND INCIDENTS

I. IDENTIFICATION
01 STATE: GA
02 SITE NUMBER: D000612937

II. HAZARDOUS CONDITIONS AND INCIDENTS (Continued)

01 ☐ J. DAMAGE TO FLORA — 02 ☐ OBSERVED (DATE: ________) ☐ POTENTIAL ☐ ALLEGED
04 NARRATIVE DESCRIPTION

01 ☐ K. DAMAGE TO FAUNA — 02 ☐ OBSERVED (DATE: ________) ☐ POTENTIAL ☐ ALLEGED
04 NARRATIVE DESCRIPTION (Include name(s) of species)

01 ☐ L. CONTAMINATION OF FOOD CHAIN — 02 ☐ OBSERVED (DATE: ________) ☐ POTENTIAL ☐ ALLEGED
04 NARRATIVE DESCRIPTION

01 ☐ M. UNSTABLE CONTAINMENT OF WASTES (Spills/runoff standing liquids/leaking drums) — 02 ☐ OBSERVED (DATE: ________) ☐ POTENTIAL ☐ ALLEGED
03 POPULATION POTENTIALLY AFFECTED: ________
04 NARRATIVE DESCRIPTION

01 ☐ N. DAMAGE TO OFFSITE PROPERTY — 02 ☐ OBSERVED (DATE: ________) ☐ POTENTIAL ☐ ALLEGED
04 NARRATIVE DESCRIPTION

01 ☐ O. CONTAMINATION OF SEWERS, STORM DRAINS, WWTPs — 02 ☐ OBSERVED (DATE: ________) ☐ POTENTIAL ☐ ALLEGED
04 NARRATIVE DESCRIPTION

01 ☐ P. ILLEGAL/UNAUTHORIZED DUMPING — 02 ☐ OBSERVED (DATE: ________) ☐ POTENTIAL ☐ ALLEGED
04 NARRATIVE DESCRIPTION

05 DESCRIPTION OF ANY OTHER KNOWN, POTENTIAL, OR ALLEGED HAZARDS

III. TOTAL POPULATION POTENTIALLY AFFECTED: ________

IV. COMMENTS

V. SOURCES OF INFORMATION (Cite specific references e.g. state files, sample analysis, reports)

GA EPD State Files.

RCRA/NPL POLICY QUESTIONNAIRE FOR INITIAL SCREENING

Site Name: Georgia Power - Plant Wansley

City: Roopville State: Ga

EPA I.D. Number: GAD 000612937

Type of Facility: Generator ✓ Transporter ___ Disposal ___
Treatment ___ Storage (more than 90 days) ___

I. RCRA APPLICABILITY	yes	no
Has this facility treated, stored or disposed of a RCRA hazardous waste since Nov. 19, 1980?		✓
Has a RCRA Facility Assessment (RFA) been performed on this site?		✓
Does the facility have a RCRA operating or post-closure permit? If so, date issued ___		✓
Did the facility file a RCRA Part A application?	✓	
If so: 1) Does the facility currently have interim status?		✓
2) Did the facility withdraw its interim status?	✓	
3) Is the facility a known or possible protective filer?		✓
Is the facility a late (after Nov. 19, 1980) or non-filer that has been identified by EPA or the State?		✓

STOP HERE IF ALL ANSWERS TO QUESTIONS IN SECTION I ARE NO

II. FINANCIAL STATUS		
Is the facility owned by an entity that has filed for bankruptcy under federal or State laws?		✓

III. RCRA ENFORCEMENT STATUS		
Has the facility lost authorization to operate or had its interim status revoked?		✓
Has the facility been involved in any other RCRA enforcement action?		✓

REFERENCE 8

"Rite in the Rain" - A unique All-Weather Writing Paper created to shed water and enhance the written image. It is widely used throughout the world for recording critical field data in all kinds of weather.

Available in a variety of standard and custom printed case-bound field books, loose leaf, spiral and stapled notebooks, multi-copy sets and computer papers.

"Rite in the Rain" All-Weather Writing [illegible]

J. L. DARLING CORPORATION
TACOMA, WA 98421-3696 USA

Rite in the Rain

ALL-WEATHER
LEVEL
Notebook No. 311

FY-2500

George [illegible]

Rossville, Georgia

[illegible]

LOGBOOK REQUIREMENTS
REVISED - NOVEMBER 29, 1988

NOTE: ALL LANGUAGE SHOULD BE FACTUAL AND OBJECTIVE

1. Record on front cover of the Logbook: TDD No., Site Name, Site Location, Project Manager
2. All entries are made using ink. Draw a single line through errors. Initial and date corrections
3. Statement of Work Plan, Study Plan, and Safety Plan discussion and distribution to field team with team members' signatures
4. Record weather conditions and general site information.
5. Sign and date each page. Project Manager is to review and sign off on each logbook daily.
6. Document all calibration and pre-operational checks of equipment. Provide serial numbers of equipment used onsite.
7. Provide reference to Sampling Field Sheets for detailed sampling information
8. Describe sampling locations in detail and document all changes from project planning documents.
9. Provide a site sketch with sample locations and photo locations.
10. Maintain photo log by completing the stamped information at the end of the logbook.
11. If no site representative is on hand to accept the receipt for samples, an entry to that effect must be placed in the logbook.
12. Record I.D. numbers of COC and receipt for sample forms used. Also record numbers of destroyed documents.
13. Complete SMO information in the space provided.

The undersigned have read + understand the subject work plan + understand the scope + objectives of this project.

John Jenkins [signature]

2

8/23 Overall + drizzling
humid + hot

1000 Arrived at site

Met with:

Carolyn L. Kennedy	GA Power	Atlanta
Darahy/ Dennis	GA Power	Plant Wansley
Randy Turner	GA Power	" "
Clark Mitchell	GA Power	" "

Never had scrubbers, so NO boiler cleaning wastes present

3 landfills

1 for wood waste - see map. Trees ...

2 for construction - covered in 1980 cable conduit

3 another construction LF

[illegible] 8/23/90

Usuum up paint wastes + store for 90 days or less. Always have done this

Changed out PCB ~~[illegible]~~ transformers + sent PCB wastes to authorized 865 ~~magnets generated~~

→ disposal area

TSS - Total Suspended Solids
Ph
Oil + Grease

→ NPDES Permitted into Chattahoochee

1 Drinking water well at recreation area thought to be ≈ 45' deep

Potable water pond overflows into storage water pond headwaters of Potable water pond is Yellow Dirt Creek

Entire plant 5725 acres [illegible] / 8/23/90

3

4

Employ ± 325 people

Well at Fer ... has a submersible pump in it.

Backwash probably ± 30-40' deep.

Ash is pumped into ash pond in a slurry.
All ponds except Ash pond are used for fishing
Ch... ... is also used for boating & fishing

They draw intake at Ch... ... for supplementary water for make up pond. Normal other intake is in Franklin

Coal ... pile (large) onsite

... 8/23/90

Boilers are cleaned chemically
in ~~plant~~ plant process - cleaning basin for collection floor drains roof drains - then

Acid cleaning basin - lined concrete basin neutralized then in line + then pumped into ash pond.

± Ash pipe empty into pond.

1100 ... around site
located well
Clark Mitchell stated that they allow clean ... (bows only) on site.

... 8/23/90

1220 Returned to plant office

site sketch provided by plant will serve as photo location map & site sketch

Also well at each pond discharge point

12:30 left facility

arrived at the assessor's office - blue print machine is out of order - we located study area on map 118 - but the plant didn't show up on "1987" photo - photo is probably older

[illegible] 4/23/10

Case No. ___________

Low Concentration yes/no

Organics

	Media	Lab	Airbill No.
	Soil	___	___
	Water	___	___

Inorganics

	Media	Lab	Airbill No.
	Soil	___	___
	Water	___	___

IDD # [illegible]
Date 8/23/90 By Whom: [illegible]
Time ___ # keyed to map: 1
Location: Plant Exhaust
Picture of: [illegible]

IDD # [illegible]
Date 8/23/90 By Whom: [illegible]
Time ___ # keyed to map: 2
Location: [illegible]
Picture of: ___

IDD # [illegible]
Date 8/23/90 By Whom: [illegible]
Time ___ # keyed to map: 3
Location: [illegible]
Picture of: ___

42

TDD # F4-8909-62
Date 8/23/90 By Whom: Jenkins
Time: # keyed to map: 4
Location: Eastern most corner of Ash Pond
Picture of: Ash Delta & Ash pumping pipes

TDD # F4-8909-62
Date 8/23/90 By Whom: Jenkins
Time: # keyed to map: 5
Location: Recreation Area
Picture of: Recreation Area well

43

48

[illegible]

R. C. (Randy) Turner
Environmental Specialist

Wa[illegible]

PW - Private well
PB - Public (Municipal) Well
MW - Monitoring (Permanent) Well
TW - Temporary (Well Point) Well
IW - Industrial Well
SW - Surface Water
SP - Spring Water
LW - Leachate Water

SS - Surface Soil
SB - Subsurface Soil
SZ - Saturation Zone
SD - Sediment
CS - Composite Soil
LS - Leachate Soil

OTHER CODES

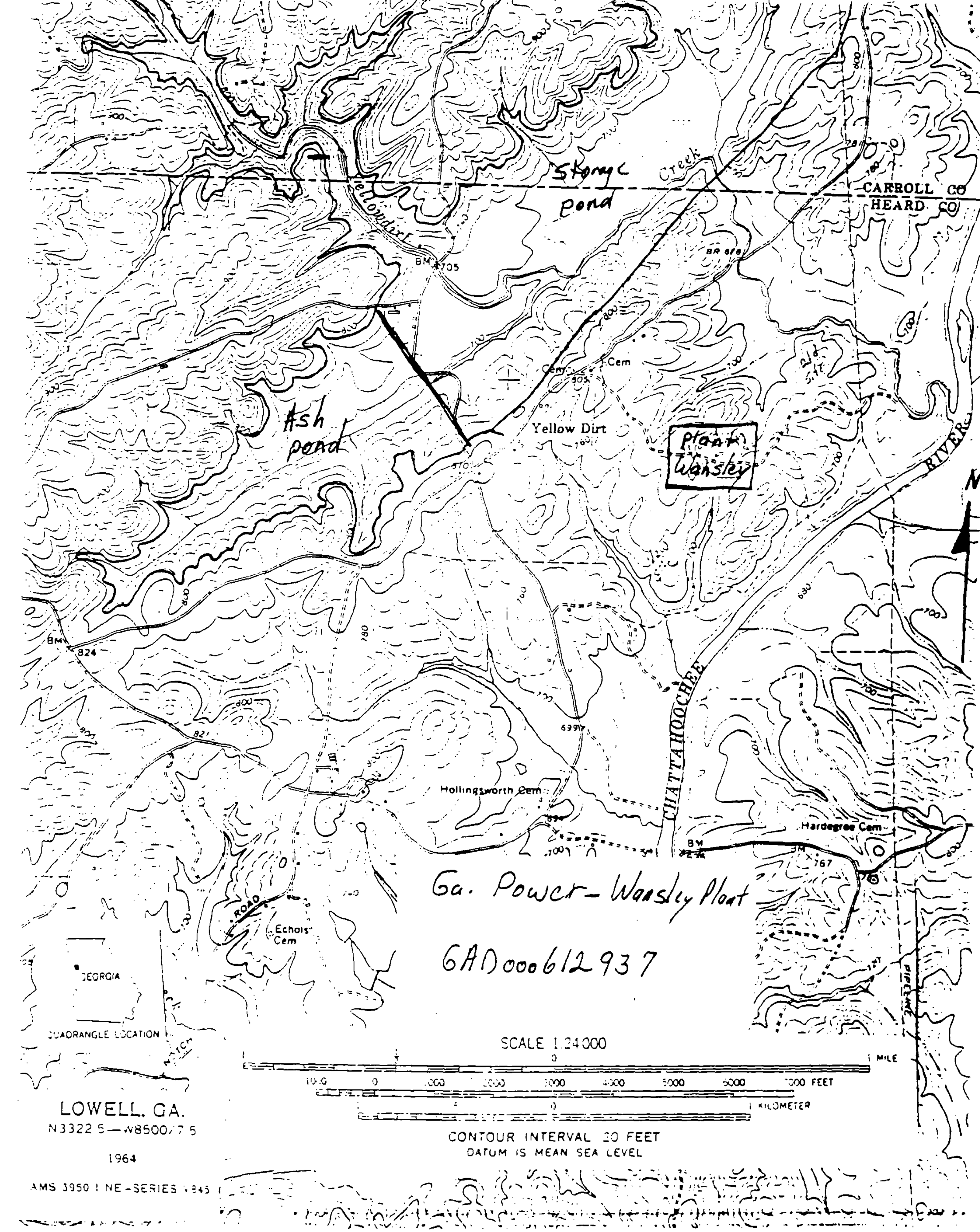
AR - Air
SL - Sludge
WA - Waste
DR - Drum

QC - Quality Control
AQ - Aquatic (Biological)
TB - Trip Blank

For all samples that are to be analyzed by the in house FIT IV laboratory, the following deviation from the standard codes are to be used: The letter "F" (denoting FIT Lab Analysis) is to be inserted in front of the sample number.

Example: Standard Auto Sampling Investigation - Temporary Well Groundwater Sample - Number 08

Appropriate Code: **SA-TW-F08**



Storage pond
Creek
CARROLL CO
HEARD CO
BM 705
BR 678
Ash pond
Yellow Dirt
Cem
Cem
Plant Wansley
RIVER
CHATTAHOOCHEE
BM 824
821
Hollingsworth Cem
Hardegree Cem
BM
767
ROAD
Echols Cem
PIPELINE
Ga. Power - Wansley Plant
GAD000612937
GEORGIA
QUADRANGLE LOCATION
SCALE 1:24 000
1 MILE
7000 FEET
1 KILOMETER
CONTOUR INTERVAL 20 FEET
DATUM IS MEAN SEA LEVEL
LOWELL, GA.
N3322.5—W8500/7.5
1964
AMS 3950 I NE-SERIES V845

REFERENCE 9

I. EPA I.D. NUMBER

III. FACILITY NAME

V. FACILITY MAILING ADDRESS

VI. FACILITY LOCATION

PLEASE PLACE [illegible]

[illegible] carefully; if any of it is incorrect, [illegible] through it and enter the correct data in the appropriate fill—in area below. Also, if any the preprinted data is absent (*the area to the left of the label space lists the information that should appear*), please provide it in the proper fill—in area(s) below. If the label complete and correct, you need not complete Items I, III, V, and VI (*except VI-B which must be completed regardless*). Complete all items if no label has been provided. Refer to the instructions for detailed item descriptions and for the legal authorizations under which this data is collected.

II. POLLUTANT CHARACTERISTICS

INSTRUCTIONS: Complete A through J to determine whether you need to submit any permit application forms to the EPA. If you answer "yes" to any questions, you must submit this form and the supplemental form listed in the parenthesis following the question. Mark "X" in the box in the third column if the supplemental form is attached. If you answer "no" to each question, you need not submit any of these forms. You may answer "no" if your activity is excluded from permit requirements; see Section C of the instructions. See also, Section D of the instructions for definitions of bold—faced terms.

SPECIFIC QUESTIONS	YES	NO	FORM ATTACHED	SPECIFIC QUESTIONS	YES	NO	FORM ATTACHED
A. Is this facility a publicly owned treatment works which results in a discharge to waters of the U.S.? (FORM 2A)		X		B. Does or will this facility (*either existing or proposed*) include a concentrated animal feeding operation or aquatic animal production facility which results in a discharge to waters of the U.S.? (FORM 2B)		X	
C. Is this a facility which currently results in discharges to waters of the U.S. other than those described in A or B above? (FORM 2C)	X			D. Is this a proposed facility (*other than those described in A or B above*) which will result in a discharge to waters of the U.S.? (FORM 2D)		X	
E. Does or will this facility treat, store, or dispose of hazardous wastes? (FORM 3)	X		X	F. Do you or will you inject at this facility industrial or municipal effluent below the lowermost stratum containing, within one quarter mile of the well bore, underground sources of drinking water? (FORM 4)		X	
G. Do you or will you inject at this facility any produced water or other fluids which are brought to the surface in connection with conventional oil or natural gas production, inject fluids used for enhanced recovery of oil or natural gas, or inject fluids for storage of liquid hydrocarbons? (FORM 4)		X		H. Do you or will you inject at this facility fluids for special processes such as mining of sulfur by the Frasch process, solution mining of minerals, in situ combustion of fossil fuel, or recovery of geothermal energy? (FORM 4)		X	
I. Is this facility a proposed stationary source which is one of the 28 industrial categories listed in the instructions and which will potentially emit 100 tons per year of any air pollutant regulated under the Clean Air Act and may affect or be located in an attainment area? (FORM 5)		X		J. Is this facility a proposed stationary source which is NOT one of the 28 industrial categories listed in the instructions and which will potentially emit 250 tons per year of any air pollutant regulated under the Clean Air Act and may affect or be located in an attainment area? (FORM 5)		X	

III. NAME OF FACILITY

1 SKIP WANSLEY STEAM ELECTRIC GENERATING STA.

IV. FACILITY CONTACT

A. NAME & TITLE (last, first, & title)	B. PHONE (area code & no.)		
2 BYERLEY T E MGR. OF ENVR. AFFRS.	404	522	6060

V. FACILITY MAILING ADDRESS

A. STREET OR P.O. BOX

3 P O BOX 214

B. CITY OR TOWN	C. STATE	D. ZIP CODE
4 ROOPVILLE	GA	30170

VI. FACILITY LOCATION

A. STREET, ROUTE NO. OR OTHER SPECIFIC IDENTIFIER

5 HIGHWAY 5

B. COUNTY NAME

HEARD

C. CITY OR TOWN	D. STATE	E. ZIP CODE	F. COUNTY CODE (if known)
6 ROOPVILLE	GA	30170	

EPA Form 3510-1 (6-80)

CONTINUE ON REVERSE

VIII. OPERATOR INFORMATION

A. NAME

8 GEORGIA POWER COMPANY

B. Is the name listed in Item VIII-A also the owner? [X] YES ☐ NO

C. STATUS OF OPERATOR *(Enter the appropriate letter into the answer box; if "Other", specify.)*

F = FEDERAL
S = STATE
P = PRIVATE
M = PUBLIC *(other than federal or state)*
O = OTHER *(specify)*

D | *(specify)*

D. PHONE *(area code & no.)*

A | 404 | 522 | 6060

E. STREET OR P.O. BOX

P. O. BOX 4545

F. CITY OR TOWN | **G. STATE** | **H. ZIP CODE**

8 ATLANTA | GA | 30302

IX. INDIAN LAND

Is the facility located on Indian lands?

☐ YES [X] NO

X. EXISTING ENVIRONMENTAL PERMITS

A. NPDES *(Discharges to Surface Water)*	**D. PSD** *(Air Emissions from Proposed Sources)*
9 N GA0024773	9 P None
B. UIC *(Underground Injection of Fluids)*	**E. OTHER** *(specify)*
9 U None	9 *(specify)*
C. RCRA *(Hazardous Wastes)*	**E. OTHER** *(specify)*
9 R None	9 *(specify)*

XI. MAP

Attach to this application a topographic map of the area extending to at least one mile beyond property bounderies. The map must show the outline of the facility, the location of each of its existing and proposed intake and discharge structures, each of its hazardous waste treatment, storage, or disposal facilities, and each well where it injects fluids underground. Include all springs, rivers and other surface water bodies in the map area. See instructions for precise requirements.

XII. NATURE OF BUSINESS *(provide a brief description)*

Generation of electricity by combustion of coal and oil.

* Wansley is jointly owned by Georgia Power Company, Oglethorpe Power Corporation, Municipal Electric Authority of Georgia, and the City of Dalton.

XIII. CERTIFICATION *(see instructions)*

I certify under penalty of law that I have personally examined and am familiar with the information submitted in this application and all attachments and that, based on my inquiry of those persons immediately responsible for obtaining the information contained in the application, I believe that the information is true, accurate and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment.

A. NAME & OFFICIAL TITLE *(type or print)*	B. SIGNATURE	C. DATE SIGNED
W.E. Ehrensperger - Sr. V.P. Power Supply	W.E. Ehrensperger	11/18/80

COMMENTS FOR OFFICIAL USE ONLY

C

II. FIRST OR REVISED APPLICATION

Place an "X" in the appropriate box in A or B below *(mark one box only)* to indicate whether this is the first application you are submitting for your facility or revised application. If this is your first application and you already know your facility's EPA I.D. Number, or if this is a revised application, enter your facility's EPA I.D. Number in Item I above.

A. FIRST APPLICATION *(place an "X" below and provide the appropriate date)*

[X] 1. EXISTING FACILITY *(See instructions for definition of "existing" facility. Complete item below.)*

8 | YR 76 | MO 12 | DAY 24 — FOR EXISTING FACILITIES, PROVIDE THE DATE *(yr., mo., & day)* OPERATION BEGAN OR THE DATE CONSTRUCTION COMMENCED *(use the boxes to the left)*

[ ] 2. NEW FACILITY *(Complete item below.)*

FOR NEW FACILITIES, PROVIDE THE DATE *(yr., mo., & day)* OPERATION BEGAN OR IS EXPECTED TO BEGIN

B. REVISED APPLICATION *(place an "X" below and complete Item I above)*

[ ] 1. FACILITY HAS INTERIM STATUS

[ ] 2. FACILITY HAS A RCRA PERMIT

III. PROCESSES – CODES AND DESIGN CAPACITIES

A. PROCESS CODE – Enter the code from the list of process codes below that best describes each process to be used at the facility. Ten lines are provided for entering codes. If more lines are needed, enter the code(s) in the space provided. If a process will be used that is not included in the list of codes below, then describe the process *(including its design capacity)* in the space provided on the form *(Item III-C)*.

B. PROCESS DESIGN CAPACITY – For each code entered in column A enter the capacity of the process.
1. AMOUNT – Enter the amount.
2. UNIT OF MEASURE – For each amount entered in column B(1), enter the code from the list of unit measure codes below that describes the unit of measure used. Only the units of measure that are listed below should be used.

PROCESS	PROCESS CODE	APPROPRIATE UNITS OF MEASURE FOR PROCESS DESIGN CAPACITY
Storage:		
CONTAINER (barrel, drum, etc.)	S01	GALLONS OR LITERS
TANK	S02	GALLONS OR LITERS
WASTE PILE	S03	CUBIC YARDS OR CUBIC METERS
SURFACE IMPOUNDMENT	S04	GALLONS OR LITERS
Disposal:		
INJECTION WELL	D79	GALLONS OR LITERS
LANDFILL	D80	ACRE-FEET *(the volume that would cover one acre to a depth of one foot)* OR HECTARE-METER
LAND APPLICATION	D81	ACRES OR HECTARES
OCEAN DISPOSAL	D82	GALLONS PER DAY OR LITERS PER DAY
SURFACE IMPOUNDMENT	D83	GALLONS OR LITERS
Treatment:		
TANK	T01	GALLONS PER DAY OR LITERS PER DAY
SURFACE IMPOUNDMENT	T02	GALLONS PER DAY OR LITERS PER DAY
INCINERATOR	T03	TONS PER HOUR OR METRIC TONS PER HOUR; GALLONS PER HOUR OR LITERS PER HOUR
OTHER *(Use for physical, chemical, thermal or biological treatment processes not occurring in tanks, surface impoundments or incinerators. Describe the processes in the space provided; Item III-C.)*	T04	GALLONS PER DAY OR LITERS PER DAY

RECEIVED EPA REGION V

UNIT OF MEASURE	UNIT OF MEASURE CODE	UNIT OF MEASURE	UNIT OF MEASURE CODE	UNIT OF MEASURE	UNIT OF MEASURE CODE
GALLONS	G	LITERS PER DAY	V	ACRE-FEET	A
LITERS	L	TONS PER HOUR	D	HECTARE-METER	F
CUBIC YARDS	Y	METRIC TONS PER HOUR	W	ACRES	B
CUBIC METERS	C	GALLONS PER HOUR	E	HECTARES	Q
GALLONS PER DAY	U	LITERS PER HOUR	H		

EXAMPLE FOR COMPLETING ITEM III *(shown in line numbers X-1 and X-2 below)*: A facility has two storage tanks, one tank can hold 200 gallons and the other can hold 400 gallons. The facility also has an incinerator that can burn up to 20 gallons per hour.

C | DUP | 1

LINE NUMBER	A. PROCESS CODE (from list above)	B. 1. AMOUNT (specify)	B. 2. UNIT OF MEASURE (enter code)	FOR OFFICIAL USE ONLY	LINE NUMBER	A. PROCESS CODE (from list above)	B. 1. AMOUNT	B. 2. UNIT OF MEASURE (enter code)	FOR OFFICIAL USE ONLY
X-1	S 0 2	600	G		5				
X-2	T 0 3	20	E		6				
1	S 0 1	800	G		7				
2	T 0 2	850	U		8				
3					9				
4					10				

IV. DESCRIPTION OF HAZARDOUS WASTES

A. EPA HAZARDOUS WASTE NUMBER — Enter the four-digit number from 40 CFR, Subpart D for each listed hazardous waste you will handle. If you handle hazardous wastes which are not listed in 40 CFR, Subpart D, enter the four-digit *number(s)* from 40 CFR, Subpart C that describes the characteristics and/or the toxic contaminants of those hazardous wastes.

B. ESTIMATED ANNUAL QUANTITY — For each listed waste entered in column A estimate the quantity of that waste that will be handled on an annual basis. For each characteristic or toxic contaminant entered in column A estimate the total annual quantity of all the non-listed waste*(s)* that will be handled which possess that characteristic or contaminant.

C. UNIT OF MEASURE — For each quantity entered in column B enter the unit of measure code. Units of measure which must be used and the appropriate codes are:

ENGLISH UNIT OF MEASURE	CODE	METRIC UNIT OF MEASURE	CODE
POUNDS	P	KILOGRAMS	K
TONS	T	METRIC TONS	M

If facility records use any other unit of measure for quantity, the units of measure must be converted into one of the required units of measure taking into account the appropriate density or specific gravity of the waste.

D. PROCESSES

1. PROCESS CODES:

For listed hazardous waste: *For each listed hazardous waste entered in column A select the code(s) from the list of process codes contained in Item III to indicate how the waste will be stored, treated, and/or disposed of at the facility.*

For non-listed hazardous wastes: For each characteristic or toxic contaminant entered in column A, select the code*(s)* from the list of process codes contained in Item III to indicate all the processes that will be used to store, treat, and/or dispose of all the non-listed hazardous wastes that possess that characteristic or toxic contaminant.

Note: Four spaces are provided for entering process codes. If more are needed: (1) Enter the first three as described above; (2) Enter "000" in the extreme right box of Item IV-D(1); and (3) Enter in the space provided on page 4, the line number and the additional code*(s)*.

2. PROCESS DESCRIPTION: If a code is not listed for a process that will be used, describe the process in the space provided on the form.

NOTE: HAZARDOUS WASTES DESCRIBED BY MORE THAN ONE EPA HAZARDOUS WASTE NUMBER — Hazardous wastes that can be described by more than one EPA Hazardous Waste Number shall be described on the form as follows:

1. Select one of the EPA Hazardous Waste Numbers and enter it in column A. On the same line complete columns B, C, and D by estimating the total annual quantity of the waste and describing all the processes to be used to treat, store, and/or dispose of the waste.
2. In column A of the next line enter the other EPA Hazardous Waste Number that can be used to describe the waste. In column D(2) on that line enter "included with above" and make no other entries on that line.
3. Repeat step 2 for each other EPA Hazardous Waste Number that can be used to describe the hazardous waste.

EXAMPLE FOR COMPLETING ITEM IV *(shown in line numbers X-1, X-2, X-3, and X-4 below)* — A facility will treat and dispose of an estimated 900 pounds per year of chrome shavings from leather tanning and finishing operation. In addition, the facility will treat and dispose of three non-listed wastes. Two wastes are corrosive only and there will be an estimated 200 pounds per year of each waste. The other waste is corrosive and ignitable and there will be an estimated 100 pounds per year of that waste. Treatment will be in an incinerator and disposal will be in a landfill.

LINE NO.	A. EPA HAZARD. WASTE NO *(enter code)*	B. ESTIMATED ANNUAL QUANTITY OF WASTE	C. UNIT OF MEASURE *(enter code)*	D. PROCESSES 1. PROCESS CODES *(enter)*	D. PROCESSES 2. PROCESS DESCRIPTION *(if a code is not entered in D(1))*
X-1	K 0 5 4	900	P	T 0 3 D 8 0	
X-2	D 0 0 2	400	P	T 0 3 D 8 0	
X-3	D 0 0 1	100	P	T 0 3 D 8 0	
X-4	D 0 0 2				included with above

CONTINUE ON PAGE

LINE NO.	A. EPA HAZARD. WASTE NO. (enter code)	B. ESTIMATED ANNUAL QUANTITY OF WASTE	C. UNIT OF MEASURE (enter code)	D. PROCESSES 1. PROCESS CODES (enter)	D. PROCESSES 2. PROCESS DESCRIPTION (if a code is not entered in D(1))
1	F001	6,400	P	S01	
2	F002				Included With Above
3	F003				Included With Above
4	F004				Included With Above
5	F005				Included With Above
6	U002				Included With Above
7	U222				Included With Above
8	U054				Included With Above
9	U159				Included With Above
10	U122				Included With Above
11	P106				Included With Above
12	U117				Included With Above
13	U123				Included With Above
14	U220				Included With Above
15	U188				Included With Above
16	U134				Included With Above
17	U210				Included With Above
18	U013				Included With Above
19	U154				Included With Above
20	U211				Included With Above
21	U151				Included With Above
22	P022				Included With Above
23	P097				Included With Above
24	D002	850	T	T02	
25					
26					

EPA I.D. NO. (enter from page 1)	
F G A T 0 0 0 6 1 2 9 3 7	T/A C: 6

V. FACILITY DRAWING

All existing facilities must include in the space provided on page 5 a scale drawing of the facility *(see instructions for more detail).*

VI. PHOTOGRAPHS

All existing facilities must include photographs *(aerial or ground–level)* that clearly delineate all existing structures; existing storage, treatment and disposal areas; and sites of future storage, treatment or disposal areas *(see instructions for more detail).*

VII. FACILITY GEOGRAPHIC LOCATION

LATITUDE *(degrees, minutes, & seconds)*	LONGITUDE *(degrees, minutes, & seconds)*
33 24 49 N	085 01 59 W

VIII. FACILITY OWNER

[X] A. If the facility owner is also the facility operator as listed in Section VIII on Form 1, "General Information", place an "X" in the box to the left and skip to Section IX below.

B. If the facility owner is not the facility operator as listed in Section VIII on Form 1, complete the following items:

1. NAME OF FACILITY'S LEGAL OWNER	2. PHONE NO. *(area code & no.)*
E	- -

3. STREET OR P.O. BOX	4. CITY OR TOWN	5. ST.	6. ZIP CODE
F	G		

IX. OWNER CERTIFICATION

I certify under penalty of law that I have personally examined and am familiar with the information submitted in this and all attached documents, and that based on my inquiry of those individuals immediately responsible for obtaining the information, I believe that the submitted information is true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment.

A. NAME *(print or type)*	B. SIGNATURE	C. DATE SIGNED
W.E. Ehrensperger	W.E. Ehrensperger	11/18/80

X. OPERATOR CERTIFICATION

I certify under penalty of law that I have personally examined and am familiar with the information submitted in this and all attached documents, and that based on my inquiry of those individuals immediately responsible for obtaining the information, I believe that the submitted information is true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment.

A. NAME *(print or type)*	B. SIGNATURE	C. DATE SIGNED

CONTINUE ON PAGE

ID Number ______ Date Logged ______

PHASE ONE

Refer to Form No:	Interim Regulatory Requirements	Indicate by your initials: Yes	No	Valid Prmig Date?
1	T/S/D Facility? (If No, return to respondent.)	JK		
3	Form 1 received?	JK		
1	Form 3 received?	JK		
1 & 3	Postmarked on or before November 19, 1980?	JK		
3	Date of operation entered?	JK		
3	Date of operation on or before November 19, 1980?	JK		
Notif. record	Notifier?	JK		
"	Notified on or before August 18, 1980?	JK		
1	Form 1, XIII B signed?	JK		
3	Form 3, IX B Signed?	JK		

(If all ten items above are initialed in the Yes column, generate Interim Status Acknowledgement and indicate the trigger date here: 12/19/80)

PHASE TWO

1	Unsure if regulated or non-regulated?	___	___
3	New facility?	___	___

1 & 3 Core items missing? If Yes, indicate which items:

Facility name___; location___; mail address___; operator info___;

certification___; process info___; waste info___; owner___; sigs___.

PHASE THREE

1 & 3 Non-core items missing? If Yes, indicate which items:

Maps___; photos___; drawings___; lat/long___.

Other observations and comments:

Received Date Stamp

(Stamp forms also)

Log out/Log in on reverse side.

REFERENCE 10

Wansley

:partment of Natural Resources
ENVIRONMENTAL PROTECTION DIVISION
270 WASHINGTON STREET S W
ATLANTA, GEORGIA 30334

JOE D. TANNER
Commissioner

J. LEONARD LEDBETTER
Division Director

August 15, 1983

FILE COPY

Mr. D. N. MacLemore, Jr.
Vice President and Chief Engineer
Power Supply Engineering and Services
Georgia Power Company
P. O. Box 4545
Atlanta, Georgia 30302

RE: Request for Facility Status Changes for Georgia Power Plants Bowen, Branch Hammond, Hatch, McDonough/Atkinson McManus, Mitchell, Scherer, Vogtle Wansley and Yates

Dear Mr. MacLemore:

This will acknowledge receipt of your request for withdrawal of your application for a Hazardous Waste Facility permit.

Based on the information provided, withdrawal of your application is warranted and your permit application has been placed in our inactive files.

Please be advised that withdrawal of your permit application invalidates any variance that you received to continue existing hazardous waste treatment storage or disposal during the permit review process and that based on our concurrence with your withdrawal request, the Federal Environmental Protection Agency will terminate your facility's interim status.

Should you wish to treat, store, or dispose of hazardous waste in the future, it will be necessary that a hazardous waste handling permit be issued, prior to the construction of such facilities, under authority of Section 8 of the Georgia Hazardous Waste Management Act and paragraphs .10 and .11 of Georgia's Rules for Hazardous Waste Management, Chapter 391-3-11.

If further clarification is needed on this matter, please feel free to contact Ms. Margaret Markey at 404/656-7802.

Sincerely,

John D. Taylor

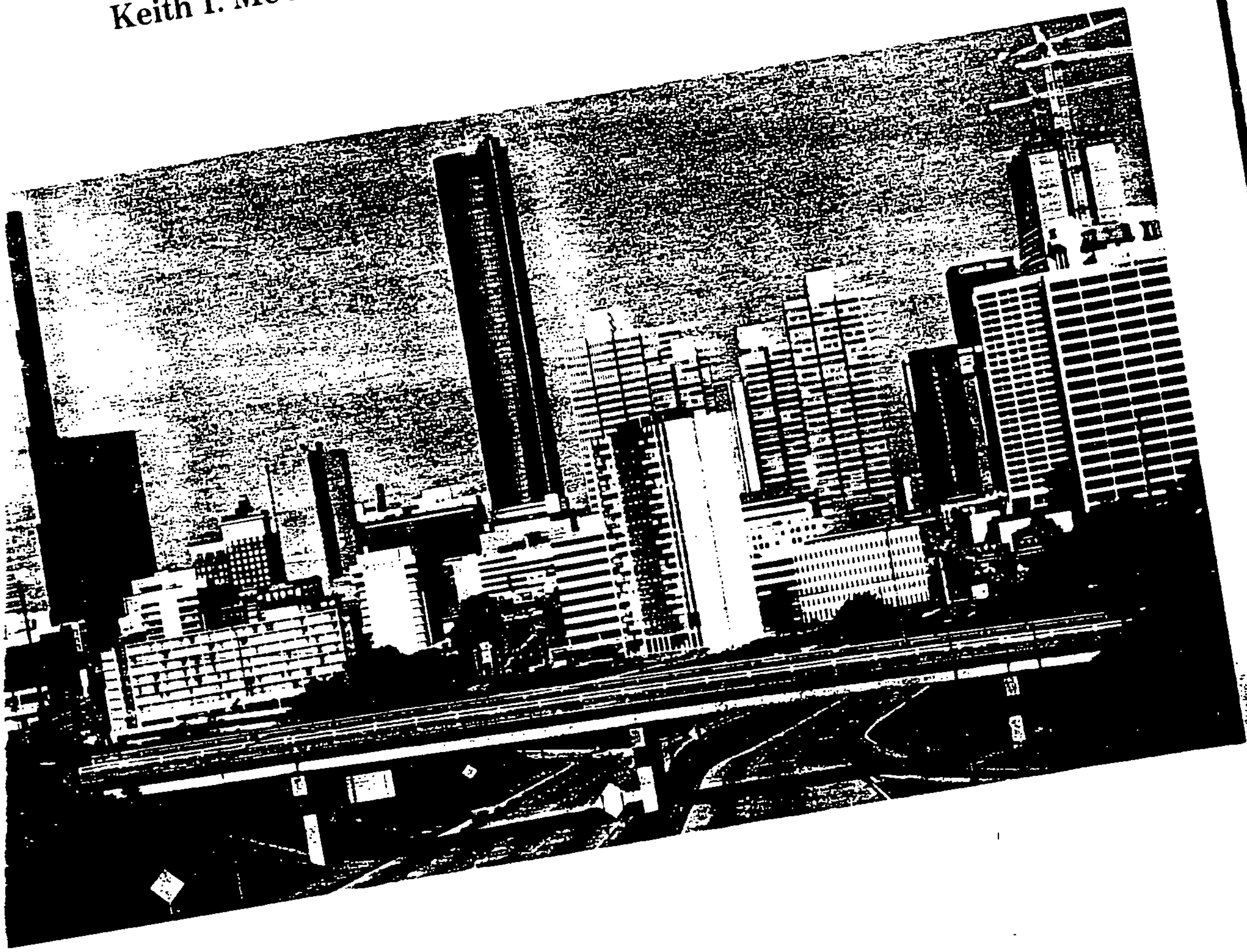
John D. Taylor, Sr., Program Manager
Industrial & Hazardous Waste
Management Program

JDT:mmb
cc: James H. Scarbrough
File: Ga. Power (Y)

REFERENCE 11

OGY OF THE GREATER ATLANTA REGION

Keith I. McConnell and Charlotte E. Abrams



Department of Natural Resources
J. Leonard Ledbetter, Commissioner

Environmental Protection Division
Harold F. Reheis, Assistant Director

Georgia Geologic Survey
William H. McLemore, State Geologist

Atlanta
1984

BULLETIN 96

CONTENTS

CONTENTS (Continued)

GEOLOGY OF THE GREATER ATLANTA REGION

Keith I. McConnell and Charlotte E. Abrams

ABSTRACT

The oldest rocks present in the Greater Atlanta Region (i.e., Corbin Gneiss Complex) are exposed in the crest of the Salem Church anticlinorium, a major northeast trending fold in the Blue Ridge portion of the study area. Nonconformably overlying these 1 b.y.-old Grenville gneisses are metasedimentary rocks of the Pinelog and Wilhite Formations. These two formations are interpreted as lithostratigraphic equivalents of units within the late Precambrian Snowbird and Walden Creek Groups of the Ocoee Supergroup. Stratigraphically above the Wilhite Formation is a metamorphosed clastic sequence that is interpreted as a lithostratigraphic equivalent of the Great Smoky Group as defined to the northeast of the study area. Rocks of the Murphy belt group are exposed in the Murphy synclinorium conformably above the Great Smoky Group. The Murphy belt group is composed predominantly of a metamorphosed succession of clastic rocks and also includes the Murphy Marble. The Murphy belt group does not extend southwest of the Murphy synclinorium east of Cartersville; however, rocks of the Great Smoky Group trend around the reentrant in the Cartersville fault into what is referred to as the Talladega belt. Units of the Talladega belt in this area are at least partially equivalent to the Ocoee Supergroup and therefore are late Precambrian in age.

Lithologic units of the Blue Ridge are separated from the rocks of the northern Piedmont by the Allatoona fault. The northern Piedmont can be divided into two major lithologic units, New Georgia and Sandy Springs Groups. The New Georgia Group is interpreted to contain the oldest units in this portion of the northern Piedmont and is characterized by a metamorphosed sequence of predominantly felsic and mafic volcanic and plutonic lithologies. The Sandy Springs Group is interpreted to conformably overlie the New Georgia Group and is composed dominantly of interlayered metavolcanic and metasedimentary rocks with a decreasing metavolcanic component upward in the stratigraphic sequence. Eastern and western belts of the Sandy Springs Group are separated by the Chattahoochee fault, a major tectonic boundary in the northern Piedmont.

Northern Piedmont rocks are separated from similar lithologies and stratigraphic sequences in the southern Piedmont by the Brevard fault zone. In the Greater Atlanta Regional Map area, the Brevard zone is a zone of early ductile and late, brittle shearing that is interpreted to have formed, at least in part, as a result of high strain along the axial zone of a large F_1 isocline. No major vertical displacement is apparent along this segment of the Brevard zone.

South of the Brevard fault zone, units defined as Atlanta Group by previous workers are interpreted in this report to be exposed in a large-scale synformal anticline. The Atlanta Group is characterized by metamorphosed sedimentary and volcanic rocks that have many similarities to lithologies north of the Brevard zone. Possible correlations between the Atlanta Group and the New Georgia and Sandy Springs Groups are presented in this report.

Paleozoic plutonic rocks present within the Greater Atlanta Regional Map area are divided into three major categories based upon chemical composition, depth of intrusion and time of intrusion relative to Paleozoic metamorphism. Earliest (category 1) intrusions were emplaced at shallow levels coincident with volcanism, are concordant to the regional trend, and are characterized by dacitic subvolcanic plutons and volcanics. Category 2 plutons were intruded syntectonically, at an intermediate level in the crust, and are characterized by moderately high concentrations of potassium, nearly concordant contacts with the country rocks and a lack of any association with volcanism. Both category 1 and 2 plutons have a metamorphic overprint. The final category of Paleozoic intrusive rocks present in the study area is dominantly granitic in composition, lacks a metamorphic overprint, is discordant to the regional trend and does not have a volcanic component. Plutons of category 3 are known to occur only south of the Brevard fault zone.

Two major regional progressive metamorphic events and seven deformational events have been recognized in the study area. The earliest deformation and metamorphism recognized occurred during the Grenville orogeny (approximately 1,000 m.y. ago) and is reflected only in basement gneisses of the Blue Ridge. The second metamorphic event is interpreted to have occurred approximately 365 m.y. ago and was associated with a major episode of isoclinal recumbent folding (F_1). Axial planar foliation (S_1) associated with this fold event represents the dominant planar feature in crystalline rocks of the area. Folds related to this deformation have not been recognized within the Valley and Ridge west of the Cartersville fault, partially supporting the existence of the fault east of Cartersville. F_2 folding postdated Paleozoic metamorphism and is responsible for the geometry of outcrop patterns in the Greater Atlanta Region. Subsequent folding events (F_3 and F_4) interfere with earlier fold patterns and complicate outcrop patterns of map units.

Twenty-eight commodities have been mined or prospected within the boundaries of the Greater Atlanta Regional Map. Of these various commodities only barite, ocher, sand, granite (dimension stone and crushed), limestone, structural clays, and marble are still being mined. Areas of extensive mining and (or) prospecting include the limestone, bauxite, and shale deposits of Floyd and Polk Counties; barite, ocher, iron and manganese deposits of the Cartersville district; volcanogenic massive sulfide and gold deposits in the northern Piedmont; and crushed and dimension stone from quarries in the Stone Mountain, Panola, Palmetto, and Ben Hill Granites and Lithonia Gneiss south of the Brevard fault zone and in the Austell, Sand Hill, Kennesaw and Dallas gneisses north of the Brevard zone.

ACKNOWLEDGEMENTS

The Atlanta Regional Map project involved many former and present day members of the Georgia Geologic Survey. Special recognition should go to Samuel M. Pickering, Jr., former State Geologist, who originated the Atlanta Regional Map project and to Joseph B. Murray and David E. Lawton who supervised the initial stages of this investigation. Also, we would like to recognize several former members of the Georgia Survey who, since their departure, have given support and guidance in the various areas that they worked. These include John O. Costello, Falma J. Moye, and Robert E. Dooley. In addition, we sincerely appreciate the support and assistance given to us by representatives of the mineral industry. In particular, the efforts of Randy Slater of Tennessee Chemical Corporation in gaining access to core from western Georgia was particularly helpful. Other members of the mineral industry who have assisted us through discussions and chemical analyses will, at their own request, remain anonymous. Outside technical review of the manuscript was by Robert D. Hatcher, Jr., James F. Tull, and James A. Whitney. Stan D. Bearden reviewed the mineral location map for the Cartersville district. Finally, we would like to express our appreciation to Gilles O. Allard and Robert H. Carpenter for their reviews of the economic geology portion of the Greater Atlanta Regional Map report and for their assistance and guidance in our efforts to understand and promote the ore deposits of west Georgia.

INTRODUCTION

Purpose and Methods

This report presents results of the Greater Atlanta Regional Map project, an effort to develop a comprehensive geologic data base for the rapidly growing Atlanta metropolitan area. The primary objective of the Atlanta Regional Map project was to provide a compilation and synthesis of existing and newly derived geologic information for the Greater Atlanta Regional Map area for use by private industry, the general public, and the geological community. A secondary objective of this project was to compile a single-source listing and map of mines and prospects in the Atlanta area primarily for use by the mineral industry. When aspects of mapping related to the Greater Atlanta Regional Map project generated interest from within the mineral exploration community, the economic part of the project was expanded to include a detailed examination of the origin of base and precious metal deposits in the Atlanta area.

The base used for the above-mentioned compilations is the map of the Greater Atlanta Region. The Atlanta map was the first of a new series of 1:100,000 scale topographic maps produced by the U.S. Geological Survey. Unlike 1:100,000 scale maps that followed it, the Greater Atlanta Regional Map was not in the 1° of longitude format. The Greater Atlanta Regional Map encompasses 1 degree, 30 minutes longitude and 1 degree of latitude and is centered on the city of Atlanta (Fig. 1). Ninety-six 7.5-minute quadrangles are contained within the boundaries of the Greater Atlanta Regional Map (Fig. 1) as are portions of three major geologic provinces (i.e., Valley and Ridge, Blue Ridge, and Piedmont).

To produce a geologic map of an area as large as that contained within the Greater Atlanta Regional Map requires an enormous amount of time and money. For that reason, existing geologic literature was reviewed in an effort to find suitable geologic mapping for compilation. Some information used in compilation of the geologic map of the study area (Plate I) was available as open-file maps at the Georgia Geologic Survey. Geologic information also was available from various hydrologic reports and nearly all of the Valley and Ridge portion of the Greater Atlanta Regional Map was compiled from these hydrologic maps.

At the start of this project much of the Blue Ridge and Piedmont contained within the boundaries of the Greater Atlanta Regional Map lacked adequate geologic mapping. A major task of the Greater Atlanta Region project was to provide mapping for these areas. In a cooperative effort, members of the Georgia Geologic Survey, U.S. Geological Survey and the University System of Georgia performed detailed and reconnaissance geologic mapping on 7.5-minute base maps. Detailed mapping generally was reserved for those areas that were exceedingly complex structurally or were of potential economic significance. Detailed petrographic studies were limited to the formal definition of specific lithologic units. Many of these petrographic studies were included in derivative reports and investigations. Chemical analyses of rocks were restricted to selected units. Most of the analytical work reported in this investigation was performed in laboratories of the Georgia Geologic Survey and U.S. Geological Survey, although some analytical work on potentially economically significant units was provided by several mineral exploration companies.

Any compilation of data from multiple sources requires compromises in the handling of differing interpretations and mapping detail in adjacently mapped areas. Also, all areas could not be mapped to the degree that would provide a complete and solid data base for interpretation. This report contains examples of all of these compromises and constraints. In particular, all areas within the study area were not mapped to the same degree of detail (see Appendix D) and, therefore, some compromises regarding lithostratigraphic contacts were necessary. In addition, controversial areas for which more than one interpretation of the geology existed required a judgement as to which interpretation was to be used on the compilation. Justification for the interpretations used are included within the text of this report.

Belt Terminology

Any author of a regional report on the geology of crystalline rocks in the southeast almost immediately encounters the problems related to the "belt" terminology which is commonly used to define the major rock groupings as long, linear belts. Although there is almost universal dislike for the "belt" terminology, terms such as Blue Ridge, Inner Piedmont, Talladega, etc., have become entrenched in the literature and in the minds of Appalachian geologists. The use of these terms has almost become an obligatory part of any manuscript written on the southern Appalachian orogen. Faced with these entrenched terms, authors of reports on crystalline rocks in the southeast must select one of four alternatives when preparing a manuscript: 1) using the belt classification of either Crickmay (1952) or King (1955); 2) using a previously

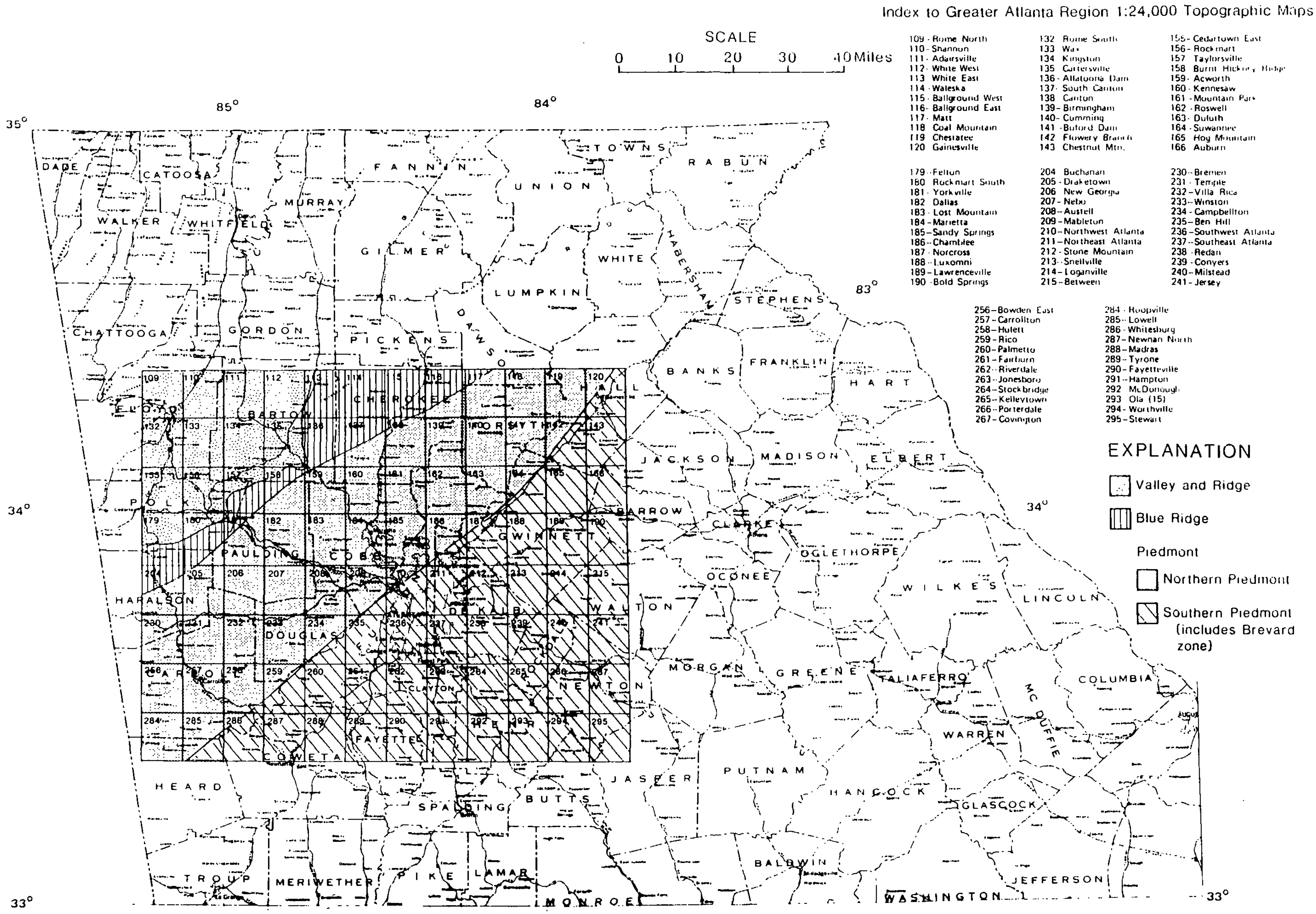


Figure 1. Greater Atlanta Regional Map area with geologic provinces and index to 1:24,000 U.S. Geological Survey topographic quadrangles.

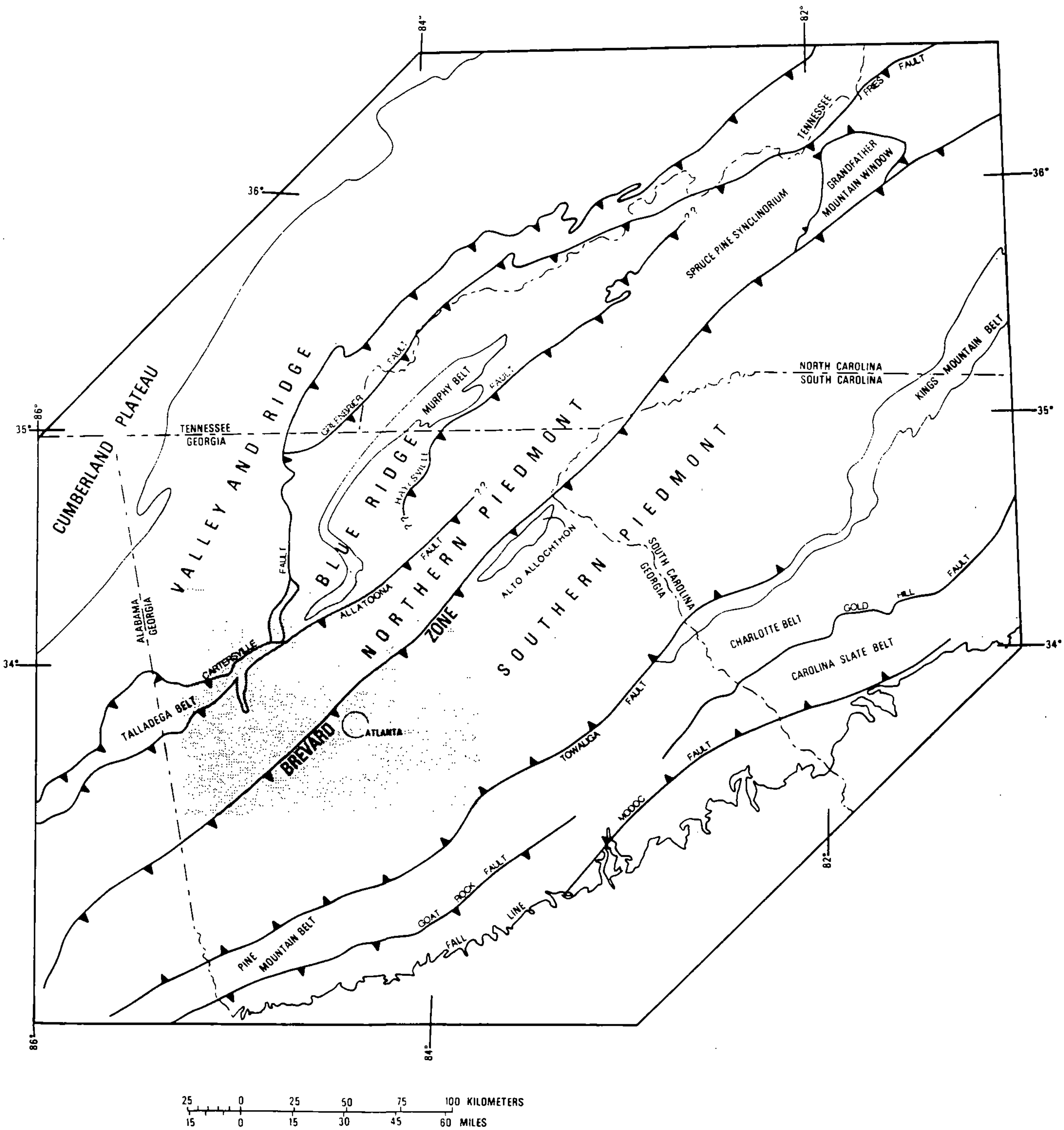


Figure 2. Regional location map showing boundaries of the Greater Atlanta Regional Map and regional setting of map area (modified after McConnell and Costello, 1982).

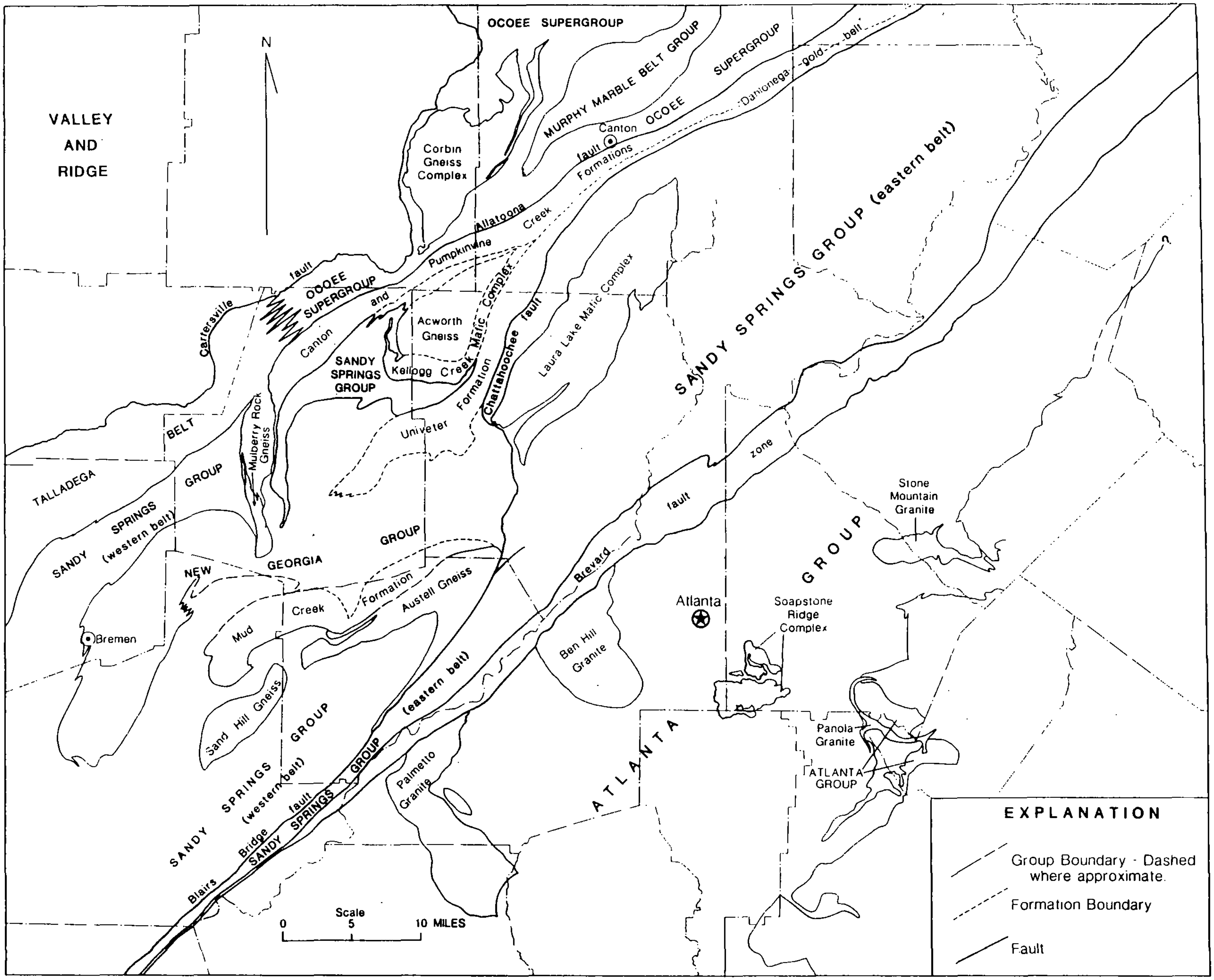


Figure 11. Group and formation boundaries of the crystalline rocks of the Greater Atlanta Regional Map.

Table 4. **Proposed correlation chart of lithologic units in the Alabama, Georgia and South Carolina Piedmont.**

<table>
<tr><th colspan="2">Alabama
Modified after Tull (1978)</th><th colspan="3">Georgia
west (this report) east</th><th colspan="2">Northeast Georgia and South Carolina
Hatcher (1974)</th><th>Georgia
Modified after Hurst* (1973)</th></tr>
<tr><td colspan="2">Emuckfaw Formation</td><td rowspan="4">Sandy Springs Group</td><td>Bill Arp Formation</td><td rowspan="2">Factory Shoals Formation</td><td rowspan="4">Tallulah Falls Formation</td><td>Greywacke, schist Quartzite, schist</td><td rowspan="4">Wedowee Formation</td></tr>
<tr><td colspan="2" rowspan="2">Wedowee Group</td><td rowspan="2">Andy Mountain Formation</td><td>Aluminous schist</td></tr>
<tr><td>Chattahoochee Palisades Quartzite</td><td>not present</td></tr>
<tr><td rowspan="2">Ashland Supergroup</td><td>Mad Indian and Hatchet Creek Groups</td><td>Dog River Formation</td><td>Powers Ferry Formation</td><td>Greywacke, schist, amphibolite</td></tr>
<tr><td>Higgins Ferry and Poe Bridge Mountain Formations</td><td colspan="3" rowspan="2">New Georgia Group</td><td colspan="2">Hornblende gneiss, amphibolite</td><td rowspan="2">Ashland Group</td></tr>
<tr><td colspan="2">Fault
Hillabee Chlorite Schist</td><td colspan="2">Basement</td></tr>
</table>

*Hurst (1973) interpreted the Wedowee to be older than Ashland.

facing criteria, and (or) fossils, this interpretation relies in part on the lithologic similarities between rocks of the Sandy Springs Group and Tallulah Falls Formation defined in northeastern Georgia by Hatcher (1971a). The similarities between these two sequences have been noted by many geologists (Hatcher, 1974, 1975; Higgins and McConnell, 1978a; Gillon, 1982). The stratigraphic interpretation presented herein is also in part dependent on Hatcher's (1971a, 1974) interpretation of an unconformable contact between Grenville basement and the Tallulah Falls Formation.

New Georgia Group

Rocks of the New Georgia Group (Abrams and McConnell, 1981a) form an irregular belt that extends from the Bremen area on the west northeastward to Canton where the belt narrows considerably and continues northeastward to at least the Dahlonega area, forming the "Dahlonega gold belt" (Fig. 11). The outcrop belt of the New Georgia Group, which is at least 130 mi. long and, at its widest, is 17 mi. wide, contains most of the base and precious metal deposits in the Greater Atlanta Regional Map area. New Georgia Group rocks are exposed in the core of a large-scale second-generation synform that plunges to the northeast. The base of the New Georgia Group is not exposed and its exact thickness is unknown. Sandy Springs Group (eastern belt) rocks are in fault contact with the New Georgia Group along the Chattahoochee and Blairs Bridge faults in the eastern and northern part of the belt (Plate I and Fig. 11). The contact between the Sandy Springs Group (western belt) and New Georgia Group near Villa Rica is gradational and this gradation is expressed by the apparent waning of volcanic activity as time progressed. The New Georgia Group is characterized by the dominance of metavolcanic rocks over metasedimentary rocks. On the other hand, the Sandy Springs Group is dominantly metasedimentary and contains a steadily decreasing volcanic component upward.

That part of the New Georgia Group that is exposed in the study area is composed of an intermingled sequence of metamorphosed felsic and mafic volcanic and subvolcanic rocks, plutonic rocks and a proportionally smaller amount of sedimentary rocks. At least two cycles of volcanism are recognizable in the New Georgia Group, but the scarcity of distinct volcanic textures due to metamorphic overprinting and deformation limits the accuracy of estimates regarding the exact proportions of felsic to mafic volcanic material in these cycles. The obliteration of original sedimentary or volcanic textures during metamorphism and intense deformation and complexities within the original volcanic pile combine to make definition of internal stratigraphy in the New Georgia Group very difficult. However, portions of the New Georgia Group are relatively well known and provide some understanding of the stratigraphy of the group. Two areas studied in detail occur on the borders of the New Georgia Group outcrop belt. Lithologic units in these areas are the Mud Creek Formation in the Villa Rica area to the southwest and the Pumpkinvine Creek Formation to the northeast. A third formation in which some idea of internal stratigraphy of the New Georgia Group can be ascertained is in the Univeter Formation located near the center of the outcrop belt of the New Georgia Group (Fig. 11).

In the vicinity of Villa Rica, Abrams and McConnell (1981a) were able to define the Mud Creek Formation of the

McConnell (1981a) also considered these rocks as well as most rocks in the Austell-Frolona antiform to be equivalent to the Sandy Springs Group, but tempered this interpretation due to the still preliminary mapping in the area. The term Roosterville group was informally introduced to define these rocks present in the Austell-Frolona antiform (McConnell and Costello, 1980b). In this report, we consider rocks present in the Austell-Frolona antiform and conformably above the New Georgia Group as equivalent to the Sandy Springs Group and have abandoned the term Roosterville group. These rocks are now interpreted as a western belt of the Sandy Springs Group due to lithologic and stratigraphic similarities. The eastern belt of the Sandy Springs Group is that defined by Higgins and McConnell (1978a, 1978b). These units are separated by the Chattahoochee-Blairs Bridge fault system.

The Chattahoochee fault was originally defined by Hurst (1973) as marking the western contact of the Sandy Springs Group. In subsequent reports, McConnell and Abrams (1978, 1982a) redefined the trace of the Chattahoochee fault, but still recognized it as representing the western and northern boundary of the Sandy Springs Group (eastern belt) for most of its length (Plate I). From a point just north of Austell, northward and then northeastward through the northeastern part of Greater Atlanta Region (Plate I), rocks of the Sandy Springs Group are thrust over New Georgia Group rocks along the Chattahoochee fault (McConnell and Abrams, 1982a). The outcrop pattern at Austell was interpreted to indicate that the Chattahoochee thrust plate was overridden by rocks on the Blairs Bridge thrust plate (McConnell and Abrams, 1978).

Sandy Springs Group (eastern belt). The Sandy Springs Group is the most areally extensive rock group in the northern Piedmont. In his report, Higgins (1966) indicated that the Sandy Springs sequence terminated at the Brevard fault zone. However, in recent years it has become apparent that Sandy Springs Group rocks occur on either side of the Brevard zone (Kline, 1980, 1981; McConnell, 1980b; McConnell and Abrams, 1982a). This interpretation is consistent with the observations of Crawford and Medlin (1974) to the southwest and Hatcher (1972, 1978b) to the northeast.

As defined by Higgins and McConnell (1978a), the Sandy Springs Group consists of four formations (Table 10): Powers Ferry Formation, Chattahoochee Palisades Quartzite, Factory Shoals Formation, and Rottenwood Creek Quartzite. Subsequent work in the type area of the Sandy Springs Group indicates that the Chattahoochee Palisades Quartzite and Rottenwood Creek Quartzite are exposed parts of a single unit that is repeated by folding. Minor lithologic variations between the two units are attributable to facies changes within the unit. Therefore, the upper quartzite unit (Rottenwood Creek Quartzite) of the Sandy Springs Group is abandoned in this report and those rocks previously defined as Rottenwood Creek are correlated with the Chattahoochee Palisades Quartzite.

Table 10. Correlation chart of the Sandy Springs Group, eastern and western belts.

<table>
<tr><th>Rocks in the Austell-Frolona Antiform
Hurst (1973)</th><th>Rocks in the Austell-Frolona antiform
Crawford and Medlin (1974)</th><th>Sandy Springs Group (western belt)
this paper</th><th>Sandy Springs Group (eastern belt)
this paper</th><th>Sandy Springs Group
Higgins and McConnell (1978)</th><th>Tallulah Falls Formation
Hatcher (1974)</th><th>"Sandy Springs sequence"
Crawford and Medlin (1974)</th></tr>
<tr><td rowspan="6">Wedowee Formation</td><td rowspan="3">Bill Arp Formation</td><td rowspan="3">Bill Arp Formation</td><td>Not defined</td><td>Not defined</td><td>Not defined</td><td>Mt. Olive Church (schist)</td></tr>
<tr><td rowspan="4">Factory Shoals Formation</td><td>Rottenwood Creek Quartzite</td><td>Quartzite-schist member and greywacke-schist member (?)</td><td>Adamson quartzite</td></tr>
<tr><td rowspan="3">Factory Shoals Formation</td><td rowspan="3">Garnet-aluminous-schist member</td><td>Backbone schist</td></tr>
<tr><td rowspan="3">Frolona formation</td><td rowspan="3">Andy Mountain Formation</td><td>Anneewakee graphitic schist-quartzite</td></tr>
<tr><td>Sparks Reservoir (schist and gneiss)</td></tr>
<tr><td>Chattahoochee Palisades Quartzite</td><td>Chattahoochee Palisades Quartzite</td><td>Not defined</td><td>Dry Creek Quartzite</td></tr>
<tr><td rowspan="3"></td><td rowspan="3"></td><td rowspan="3">Dog River Formation</td><td rowspan="3">Powers Ferry Formation</td><td rowspan="3">Powers Ferry Formation</td><td rowspan="3">Greywacke-schist-amphibolite member</td><td>Chapel Hill Church (gneiss and schist)</td></tr>
<tr><td>Mt. Vernon Church graphitic schist-quartzite</td></tr>
<tr><td>Mt. Vernon Church schist</td></tr>
</table>

Plate Ib

Southern Piedmont and Brevard Fault Zone

(modified after Atkins and Higgins, 1980; and Kline, 1981)

Mesozoic

d : diabase dikes

my / bz / bzm : Ductally sheared rocks: includes *Brevard fault zone undifferentiated (bz)*, Brevard zone mylonites (bzm), and other mylonites (my).

Carboniferous

Cs — Stone Mountain Granite

Cpa — Panola Granite

Cb — Ben Hill Granite

sr / t / Cp — Palmetto Granite: includes the Snake Rag phase (sr), and the Tyrone phase (t).

Middle Paleozoic

lig — Lithonia Gneiss

Proterozoic Y and (or) Z and (or) Lower Paleozoic

Pzss / Pzum / Pzsa / Pzsas — Soapstone Ridge Complex: includes a schist unit (Pzss), an amphibolite unit (Pzsa), an amphibolite and schist unit (Pzsas) and a coarse-grained ultramafic unit (Pzum).

n / l — Snellville Formation: includes the Norris Lake Schist Member (n) and the Lanier Mountain Quartzite Member (l).

Sandy Springs Group

fs — Factory Shoals Formation

cpq — Chattahoochee Palisades Quartzite

pfu — Powers Ferry Formation undifferentiated

Atlanta Group

iy — Inman Yard Formation

pl / h — Promised Land Formation: includes the Hannah Member (h).

ng — Norcross Gneiss

wc — Wolf Creek Formation

cl — Clairmont Formation

se — Senoia Formation

wac — Wahoo Creek Formation

st — Stonewall Formation

f / tc / ca — Clarkston Formation: includes the Fairburn Member (f), Tar Creek Member (tc), and undifferentiated Clarkston Formation (ca).

bci — Big Cotton Indian Formation

icq — Intrenchment Creek Quartzite

cc — Camp Creek Formation

New Georgia Group

Unassigned and Unnamed Rocks

um — meta-ultramafic rocks

amp — amphibolite and hornblende gneiss

bgn — predominantly biotite gneiss

ggn — granitic gneiss

sg — sillimanite-graphite schist

m — marble

bgn/amp/sch — biotite gneiss, amphibolite, and mica schist undifferentiated

q — quartzite

bms — biotite muscovite schist

Symbols

CONTACT, DASHED WHERE INFERRED

THRUST FAULT, DASHED WHERE INFERRED

D U REVERSE FAULT, DASHED WHERE INFERRED, DOTTED WHERE UNCERTAIN

FLINTY CRUSH ROCK

STRIKE-SLIP FAULT

Ground Water of the Piedmont and Blue Ridge Provinces in the Southeastern States

By H. E. LeGrand

GEOLOGICAL SURVEY CIRCULAR 538

Washington 1967

CONTENTS

ILLUSTRATIONS

TABLES

Ground Water of the Piedmont and Blue Ridge Provinces in the Southeastern States

By H. E. LeGrand

INTRODUCTION

This circular summarizes the underground water conditions in the Piedmont and Blue Ridge provinces of the Southeastern States—the region shown on the geologic map (fig. 1).

There are several ways of developing water from the ground in this region. In earlier days springs were used because they are common in coves or on lowland slopes. Almost all springs in the region yield between ½ to 3 gallons per minute and rarely show a significant decline in yield during dry weather. Dug wells were common in the past, but they are being replaced by bored and drilled wells. Bored wells, like dug wells, are as much as 2 feet in diameter and are commonly lined with concrete or terra cotta pipe; these wells do not extend into hard rock and go dry if the water table falls below the bottom of the well. Drilled wells, which are now the most common source of ground-water supply and which are the chief concern of this report, are cased to the hard rock and extend as open holes into the rock. Although some drilled wells are as small as 2 inches in diameter and others are as large as 10 inches, the most common size is about 5 or 6 inches. Almost every well in recent years has been properly constructed to prevent water on the ground from running down the outside of the casing into the well.

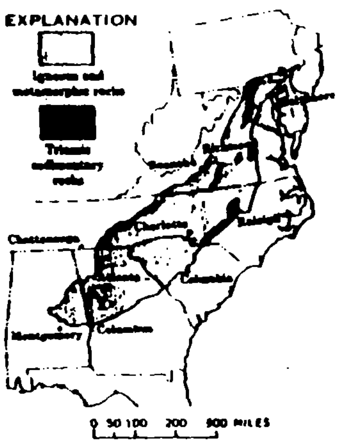


Figure 1.—Generalized geologic map. Areas underlain by igneous and metamorphic rocks are better suited to numerical rating of well sites than areas underlain by Triassic sedimentary rocks.

EVALUATING SITES

A special attempt is made to help those who are interested in the yields of wells. Because yields of individual wells in the region vary greatly within distances as short as 100 feet, estimates of potential yields of prospective wells are difficult to make. This fact has led frequently to water shortages, excessive costs, inconveniences, or undue anxiety in many cases. As the yield of a well is unpredictable, the next best approach is to attempt to show, on a percentage basis, the chance for a certain yield from a well for different conditions.

Although many factors determine the yield of a well, two ground conditions, when used together, serve as a good index for rating a well site. These conditions are topography and soil thickness. The ratings are based on the following statement: High-yielding wells are common where thick residual soils and relatively low topographic areas are combined, and low-yielding wells are common where thin soils and hilltops are combined. By comparing conditions of a site according to the topographic and soil conditions one gets a relative

rating value. For example, the following topographic conditions are assigned point values:

Points	Topography
0	Steep ridge top
2	Upland steep slope
4	Pronounced rounded upland
5	Midpoint ridge slope
7	Gentle upland slope
8	Broad flat upland
9	Lower part of upland slope
12	Valley bottom or flood plain
15	Draw in narrow catchment area
18	Draw in large catchment area

Figure 2 shows values for certain topographic conditions. Figure 3 shows rating values for soil thickness. The soil zone in this report includes the normal soils and also the relatively soft or weathered rock. The topographic conditions and soil conditions are separately rated, and the points for each are added to get the total points which may be used in table 1 to rate a site.

Using two well sites, A and B, as examples, we can evaluate each as to the potential yield of a well. Site A, a pronounced rounded upland (4-point rating for topography in fig. 2) having a relatively thin soil (6-point rating for soil characteristic in fig. 3), has a total of 10 points. In table 1 the average yield for site A is 6 gpm (gallons per minute). This site has a 65-percent chance of yielding 3 gpm and a 40-percent chance of yielding 10 gpm. Site B, a

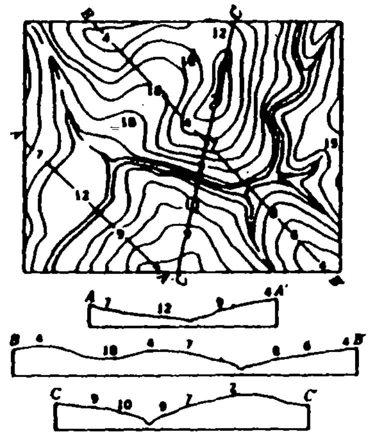
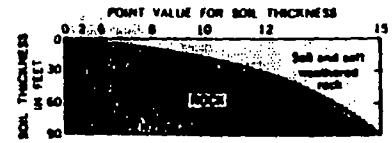


Figure 2.—Topographic map and profiles of ground surface showing rating in points for various topographic positions.



POINT VALUE	CHARACTER OF SOIL AND ROCK
0-2	Bare rock—almost no soil
2-6	Very thin soil—some rock outcrops
6-9	Soil thin—a few rock outcrops
9-12	Moderately thick soil—no fresh outcrops
12-15	Thick soil—no rock outcrops

Figure 3.—Rating in points for various conditions of soil thickness.

Table 1.—*Use of numerical rating of well site to estimate the percent chance of success of a well*

[Data are based on maximum depth of 300 feet or maximum drawdown of water level of about 200 feet. No interference from pumping is assumed. Numerical rating is obtained by adding rating in points for topography and soil thickness]

Total points of a site	Average yield (gpm)	Chance of success, in percent, for a well to yield at least—				
		3 gpm	10 gpm	25 gpm	50 gpm	75 gpm
5	2	45	18	6	2	------
6	3	50	20	7	3	------
7	3	55	25	8	3	------
8	4	55	30	11	3	------
9	5	60	35	12	4	------
10	6	65	40	15	5	------
11	7	70	43	19	7	------
12	9	73	46	22	10	------
13	11	77	50	26	12	------
14	12	80	52	30	14	------
15	14	83	54	33	16	------
16	16	85	57	36	18	------
17	17	86	60	40	20	12
18	20	87	63	45	24	15
19	23	88	66	50	25	18
20	26	89	70	52	27	20
21	28	90	72	54	30	22
22	31	91	74	56	35	24
23	34	92	76	58	38	26
24	37	92	78	60	40	29
25	39	93	80	62	43	33
26	41	93	81	64	46	36
27	43	94	82	66	48	40
28	45	95	83	68	50	42
29	48	95	84	71	53	44
30	50	96	87	73	56	47
30+	50	97	91	75	60	50

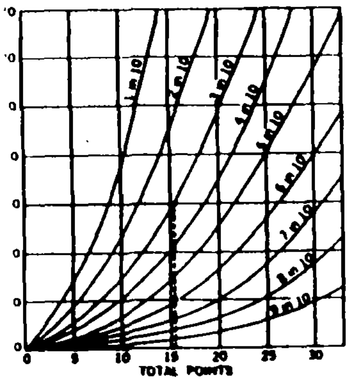


Figure 4.—Probability of getting a certain yield from a well at different sites having various total-point ratings.

draw or slight sag in topography (18-point rating) having a moderately thick soil (12-point rating), has a total of 30 points, an average yield of 50 gpm, and a 73-percent chance of yielding 25 gpm. Referring to figure 4, we see that the 10-point site has less than 1 chance in 10 of yielding 40 gpm whereas the 30-point site has better than an even chance of yielding 40 gpm.

Some topographic conditions of the region and a few topographic ratings are shown in figure 5. Wells located on concave slopes are commonly more productive than wells on convex slopes or straight slopes. Broad but slight concave slopes near saddles in gently rolling upland areas are especially good sites for potentially high-yielding wells. On the other hand, steep V-shaped valleys of the gully type may not be especially good sites, and they should be avoided if surface drainage near the well is so poor that contamination is possible.

More difficulty is likely to occur in rating character of soil and rock than in rating

Figure 5.—Countryside in the Blue Ridge province showing approximate ratings for topography.

Figure 6.—The soil cover is likely very thin over these rock outcrops (soil-thickness rating 0 to 4 points).

topography. Everyone should be able to determine by observation if the soil is thin (less than 7 soil and rock points as shown in figure 6) and if the soil is fairly thick (more than 10 soil and rock points), but the intermediate ratings are difficult to make. If the observer is unsure of the soil and rock rating above the 8-point (thin soil) value he may choose a 10-point value for the site with assurance that he is fairly correct. White quartz of flint, which occurs as veins and as rock fragments on the ground, is not considered a true rock in this report because it persists in the soil zone; a quartz vein in many cases is considered to be a slightly favorable indication of a good well site.

The numerical rating system is not intended to be precise. One person may rate a particular site at 15 points, whereas another person may rate it at 17 points; such a small difference in rating would not be misleading. Almost everyone's rating will be within 5 points of an average rating for a site.

YIELD

The term "yield" is not definite but is the reported capacity of a well to produce water, generally during a short pumping test. The water level in a well will stabilize if a certain limited yield or withdrawal of water is maintained; however, a greater withdrawal or yield will cause the water level to fall. In many cases the water level continues to fall until the pumping stops so that continuous pumping would result in a smaller yield than that estimated earlier. The percentage of relative yield is not directly proportionate to the percentage of drawdown of the water level, but the greater percentage of yield is reached before the greater percentage of drawdown. Figure 7 shows an approximate relation of drawdown to yield for an average well in the region. Note that the yield-drawdown relationships of all wells lie within the shaded zone and that average conditions occur on or near the heavy line. As an example of the relation between yield and drawdown, we may consider a well 220 feet deep having a static water level of 20 feet below land surface. (See fig. 8.) This well yields 40 gpm with a pumping level at a depth of nearly 220 feet; the pump might better be set at 120 feet (50 percent of drawdown or half the thickness of the water) where about 36 gpm or 90 percent of the relative yield could be realized. It is unnecessary and uneconomical to lower the water level of a well to a position near the bottom unless the yield is so poor that the water stored in the well is needed.

There is no simple definition of the yield of a well—especially in the Blue Ridge and Piedmont provinces. Yields for various levels of the water in the pumped well are rarely known. The yields in this report are considered to be standard for wells about 300 feet deep which are pumped about 12 hours each day and in which drawdown of the water level is about 200 feet; it is assumed that there is no interference by pumping from other wells, which would increase drawdown.

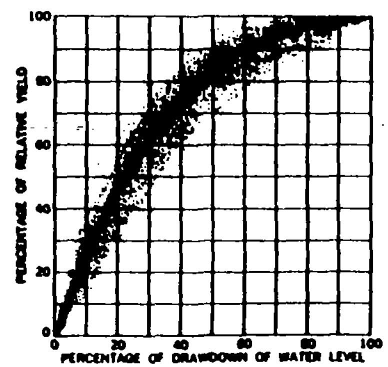


Figure 7.—The curve shows that an increase in yield of a well is not directly proportionate to an increase in drawdown of the water level. A yield of nearly 80 percent of the total capacity of a well results from lowering the water level only 40 percent of the available drawdown.

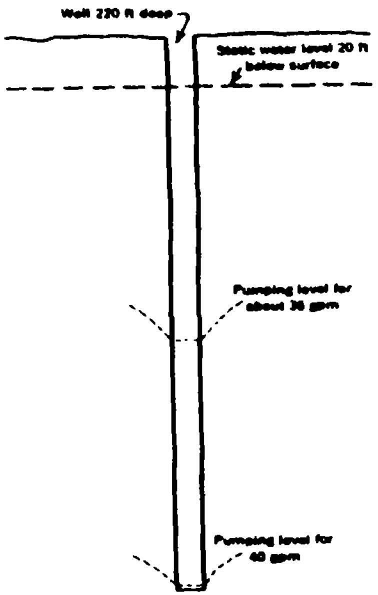


Figure 8.—Yield of a well at two different pumping rates.

DEPTH OF WELLS

How deep should a well be drilled? This question is not easy to answer for an individual well. In most places fractures in the rock get smaller and fewer with depth and deep drilling may not be economical. Figure 9 shows the percentage of total yield for certain depths in an average well.

The following table shows the percentage of wells that reach their maximum yields at certain depths below which drilling is useless. As

Depth (feet)	Percentage of wells
70	25
100	30
150	50
200	70
300	85
400	93

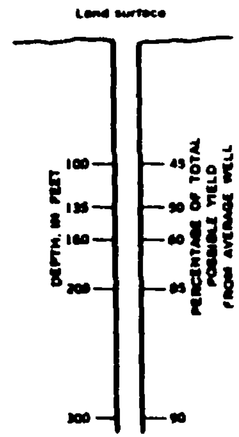


Figure 9.—Extent to which deepening of average well increases the yield.

most of the interconnecting fractures occur in a zone no deeper than 150 feet below the land surface, it may be wise to drill no deeper than 150 feet if the yield is very poor, or no deeper than 300 feet in almost all cases.

FRACTURES IN THE ROCK

Figure 10 illustrates six different fracture patterns in rocks penetrated by wells. To simplify the illustrations the water table and soil thickness are considered uniform, and each well, cased to 50 feet, is 250 feet deep. The approximate number of times each general pattern of fractures occurs in 100 wells is shown in percentage beneath each type. Well A penetrates no fractures below the casing; therefore, the well yields no water. Well B penetrates a fracture zone in which two or more fractures occur a few feet below the casing. This type of well is common. It may yield as much as 10 to 20 gpm for a period of several minutes until the fractures are drained. Then its yield will likely decline suddenly, and the amount of decline will depend upon the amount of water transmitted to the well by the soil and the underlying thin zone of fractured rock. That part of the well below the fracture zone contributes no water and acts only as a storage reservoir into which water drains. The yield of this well does not increase with increased drawdown. Well C penetrates only one fracture, a large one near the

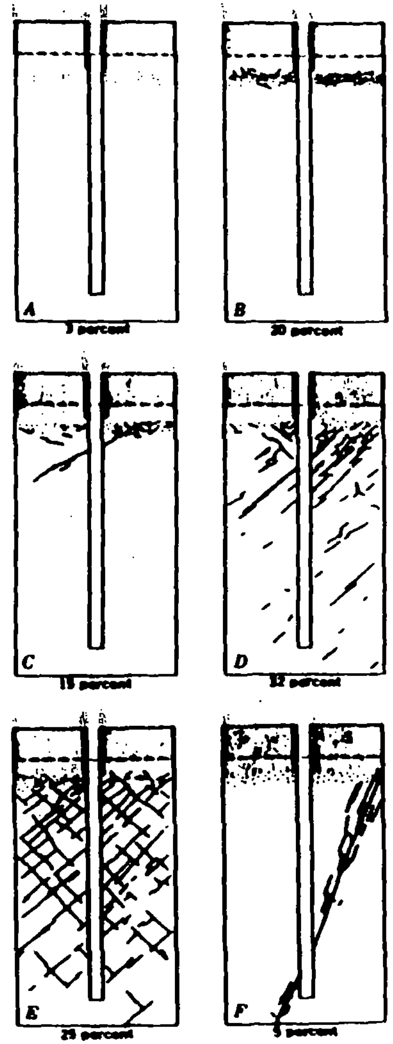


Figure 10.—Six types of ground conditions showing distribution of fractures that influence the yields of wells. The stippled pattern represents soil and soft rock; the dashed line is the water table. The degree of frequency of the different types is shown in percentage.

top of the fresh rock. This well is similar to well B. It may yield considerable water for a few minutes until the stored water in the fracture is drained. The perennial yield, under continuous pumping, will depend on the permeability of the soil and weathered rock and on the amount of water that is released to the fracture. Well D penetrates several fractures, which contribute small amounts of water, and a large fracture at a depth of about 90 feet. Well E penetrates several small- to medium-sized fractures. These fractures are larger and more closely spaced in the upper part of the bedrock. Well F penetrates only one fracture—a large one below a depth of 200 feet.

WATER TABLE

The water table, or upper surface of the underground reservoir, continuously fluctuates and reflects changes in underground storage. During droughts we see evidence of a falling water table when many shallow wells go dry. We also can detect a lowering of the water table locally around wells from which water is pumped. There is a continual discharge of ground water by seepage into streams, by evaporation, and by transpiration through vegetation. The discharge causes a gradual lowering of the water table except for periods during and immediately after significant precipitation when recharge to the underground reservoir exceeds the discharge from it and the water table rises. Figure 11 shows the trends of water-level fluctuation in a well at Chapel Hill, N. C. The water level in this well is controlled entirely by natural conditions, and its fluctuation is typical of that in the region. There is a characteristic seasonal change in the water table, which begins to decline in April or May owing to the increasing amount of evaporation and transpiration of plants. In November or December, when much of the vegetation has become dormant, the precipitation first makes up the summertime soil-moisture deficiency and then again becomes effective in producing recharge, and the water table begins to rise. In a year of normal rainfall the recharge to the underground reservoir is approximately equal to the discharge from it, so that the water table

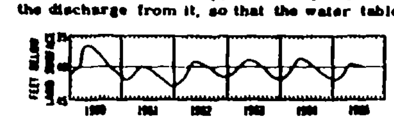


Figure 11.—The water table generally declines in summer and fall but rises to a high level in early spring, as shown by the record of this well in Chapel Hill, N. C.

Table 2.—Concentrations of chemical constituents and their characteristic effects on water use in the region

[Concentration in parts per million except as indicated. Occurrence, where noted, is given in parenthesis after concentrations]

Constituents	Concentration	Characteristic effects on water use
Silica (SiO_2)	Rarely less than 15 or more than 45, commonly 20 to 35.	Forms hard scale in pipes and boilers but not normally a serious problem in the region.
Iron (Fe)	Commonly less than 0.3 in natural water, but corrosion of iron pipes from water with pH less than 6.8 causes a fairly common iron problem.	More than 0.3 ppm stains laundry, utensils, and fixtures reddish brown.
Calcium (Ca) and magnesium (Mg)	Rarely less than 5 or more than 60 (commonly 5 to 20 in water beneath light-colored soils and 15 to 50 in water beneath dark-colored soils).	Cause most of the hardness and scale-forming properties of water. (See hardness below.)
Bicarbonate (HCO_3)	Rarely less than 15 or more than 150, commonly 30 to 100.	Concentrations in region are not generally high enough to cause trouble.
Sulfate (SO_4)	Rarely less than 1 or more than 100, commonly 1 to 40.	Concentrations in region are not generally high enough to cause trouble.
Chloride (Cl)	Rarely less than 1 or more than 40, commonly 1 to 20.	Salty taste to water having more than a few hundred parts per million.
Fluoride (F)	Rarely more than 1, commonly 0.0 to 0.8.	Concentration between 0.6 and 1.7 ppm in water retards decay of teeth, but amounts in excess of 1.5 ppm may cause mottled enamel of teeth.
Nitrate (NO_3)	Rarely more than 20, commonly less than 10.	Where concentration is greater than 20 ppm, contamination from sewage may be suspected. Water of concentrations greater than 45 ppm may be harmful to babies.
Dissolved solids	Total of all mineral matter rarely exceeds 250, commonly 70 to 150.	Water containing more than 1,000 ppm of dissolved solids is unsuitable for most purposes.
Hardness as equivalent $CaCO_3$	Rarely less than 10 or more than 180 (commonly 10 to 50 in water beneath light-colored soils and 40 to 200 in water beneath dark-colored soils).	Causes consumption of soap before lather will form. Hard water forms scale in boilers and hot water heaters. Water whose hardness is less than 60 ppm is considered soft; 61 to 120 ppm, moderately hard; 121 to 180 ppm, hard; more than 180 ppm, very hard.
pH	Rarely less than pH of 5.5 or more than 7.5 (commonly 5.5 to 6.8 in water beneath light-colored soils and 6.8 to 7.5 in water beneath dark-colored soils).	Values less than 7.0 indicate acidity, and corrosiveness of water generally increases with decreasing pH.

at the end of the year is at about the same level as at the beginning of the year. Wells drilled into rock may, when pumped at full capacity, yield slightly less during the driest part of the year when the water table is low. Yet there appears to be no evidence to support the general belief that the water table has been declining during recent years.

CHEMICAL QUALITY OF THE WATER

In comparison with ground water in widely scattered regions of the world, the water in the Piedmont and Blue Ridge provinces ranks among the best in chemical quality. (See table 2.) Most of the water is low in total dissolved solids and is generally soft, but some is moderately hard.

Iron in water is the most common complaint. As little as 0.4 ppm (parts per million) will cause a red stain on plumbing fixtures. About 5 of every 10 wells yield water with less than 0.3 ppm of iron. About 4 of 10 wells yield water with just enough iron to cause a slight stain, and about 1 of 10 wells yields water that has considerable iron. Some iron problems result when iron is dissolved from rocks, and other problems result when water, moving through iron pipes, consequently picks up a brown iron stain by corrosion. It is important to determine the source of the iron, whether dissolved from the rocks or from the pipes, before methods for its removal are employed. Most of the water is satisfactory for use without any type of treatment (table 2). Yet an analysis of the water should be made as soon as a well is drilled to determine if treatment is necessary. It is not possible to determine the quality of water before a well is drilled.

CONTAMINATION OF GROUND WATER

In view of the many hundreds of thousands of wells that are interspersed with about an equal number of septic tanks and other waste sites, it is proper to give serious attention to the possibility of contaminating an individual water supply. The tendency for ground water—and contaminants that might be in it—to move naturally from upland areas toward stream valleys offers help in planning wells and waste sites to avoid contamination. A well that is pumped may modify the natural movement of water and draw contaminated water toward it; this condition is more likely where the soil is thin or absent than where it is thick. Care should be taken to see that no water from the land surface can seep easily into the well around the casing. Not only is the well site important but so is the waste site. In most cases the chances of contaminated water from a waste site moving into a well are not easy to predict, but a few general statements can be made. For example, at a waste site (1) a deep water table is safer than a shallow water table, (2) thick soil is safer than thin soil or rock outcrops, (3) sandy soil with some clay may be better than a clean sandy soil or a sticky clay soil, and (4) a slope of both the land surface and the water table away from a well is better than one toward it.

The soil and weathered rock are generally effective in preventing waste materials from passing through to underlying rock fractures, but the combination of (1) certain types of wastes, (2) excessive quantities of disposed wastes, and (3) thin soils may result in contaminated water reaching bedrock fractures. Once in the bedrock fractures the contaminated water may move easily to water supplies. Only a small percentage of wells have been contaminated, but proper care in locating and constructing wells and waste sites must be taken to minimize the risk of contamination. Minimum standards specified by health officials, such as those relating to permeability of the soil, distance between a well and a waste site, and depth of the water table, must be followed.

GENERAL STATEMENTS ABOUT GROUND WATER IN THE REGION

1. Ground water may be considered as occurring in an underground reservoir, the water being held in the open spaces of the rock materials. The water table, representing the top of the reservoir, generally lies in the clay, or disintegrated rock materials. In the lower part of the reservoir, water occurs in interconnecting fractures in bedrock; the fractures diminish in number and size with increasing depth. Water enters the fractures by seeping through the overlying clay, and drilled wells draw water from these fractures. The source of this water is precipitation in the general area of a well and not in some remote place.

2. A layer of residual soil and weathered rock lies on the fresh rock in most places; the thickness of the soil and weathered rock ranges from zero to slightly more than 150 feet.

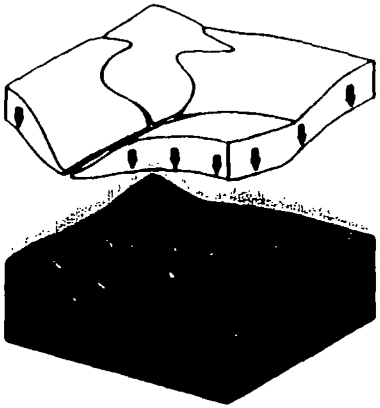


Figure 12.—Dry zone (above water table) lifted up to show water table & surface of saturated zone. Movement of water (arrows) tends to be downward in the dry zone and lateral toward streams in the saturated zone.

3. The water table has a hill and valley relation that approximately conforms with surface topography, although the water table is somewhat flatter. (See fig. 12.) For example, a creek or river is the *surface* expression of the water table in a valley, but beneath a hill the water table may be 30 to 70 feet below the ground surface. Ground water, like surface water, has the tendency to drain away from the hills to the valleys. This tendency helps in planning the location of wells in relation to other wells and to sources of possible contamination.

4. A close network of streams prevails, and in most places on an upland area a perennial stream is less than 1 mile away.

5. Toward the streams is a continuous flow of ground water. Some of the outflowing ground water is used up by evaporation and by transpiration of plants in the valley areas; the remainder of the water discharges as small springs and as bank and channel seepage into the streams.

6. The natural movement of ground water is relatively short and is almost everywhere restricted to the zone underlying the gross topographic slope extending from a particular land-surface divide to the adjacent streams.

7. In ideal cases the pumping of a well causes the water table to be *depressed* smoothly in the shape of an inverted cone, the apex of the cone being in the well; however, the erratic distribution of rock fractures and the contrasting nature of permeability between rock fractures and overlying soils cause the depressed part of the water table to extend unevenly around a well. Where two heavily pumped wells are within a few hundred feet of each other, there is a strong likelihood of some interference of pumping level between the two, but in most cases there is not any appreciable interference between low-yielding wells a few hundred feet apart. From a pumped well the depressed part of the water table rarely extends beneath a perennial stream or beneath a hilltop to a slope on the opposite side. Well interference is local, and there is no regional lowering of the water table because of pumping.

8. The relation of the depth of a well to yield of the aquifer is not simple. In spite of some beliefs, water already available to a well is rarely lost by drilling deeper; therefore, there is always a chance of getting a larger supply by increasing the depth of the well. Yet this chance becomes poorer as the well deepens because the interconnecting fractures and the ability of the rocks to store and transmit water decrease significantly with depth. More than 90 percent of all ground water occurs in the first 100 feet below the water table. Generally two wells 200 feet deep each will yield more water than one well 400 feet deep.

9. The relationship of topography to yield is emphasized. The great majority of wells are located on hills or smooth upland slopes because of convenience and because these locations appear safe from sources of contamination. Yet the percentage of low-yielding wells is much greater on hills and upland convex slopes than in lowlands or draws (concave slopes that lead upward from a valley to a saddle or sway-backed position in a ridge). Steep-sided depressions, such as gullies and ravines, should not be considered acceptable sites for wells.

10. In general, wells are more productive and tend to have a more stable year-round yield where there is a thick mantle of soil than where bare rock crops out. The presence of a soil cover and the absence of rock outcrop

suggest that water moves downward into the rock and is not readily shunted toward the adjacent valley; in fact, the soil cover suggests that interconnecting rock fractures are available to store water and to transmit it to wells. Where there is a good soil cover, the water table generally lies in it; therefore, the storage capacity in the vicinity is much greater than where bare rock is exposed and where the only water in storage is in the rock fractures that might be quickly drained.

11. Simple clear-cut statements about the water-yielding properties of the various types of rocks are not easy to make. There are many varieties of igneous and metamorphic rocks, but for a discussion of their groundwater properties they may be grouped as follows: (1) Somewhat massive igneous rocks, such as granite, and (2) metamorphic rocks, such as schists, gneisses, and slates, which may show an alinement of minerals or an alinement of cleavage planes or openings along which water may move. In some places a type of rock may have distinctive water-bearing characteristics, but, if so, it is also likely to show distinctive topographic and soil-mantle features. Topography and soil-mantle features are readily observed and may be used as criteria for predicting the water-yielding potential of a well site, whereas the water-bearing characteristics of a type of rock by itself may be obscure. At any rate, there are too many complex factors involved to justify generalizations about the yield of wells in individual types of rock.

12. Whenever water is pumped from a well, the water level is lowered in and around the well. The drawdown increases with an increase in the rate of pumping, although this relation is not simple. For example, a well yielding 20 gpm with a drawdown of 50 feet will not double its yield by increasing the drawdown to 100 feet. Instead, it will yield less than 40 gpm and perhaps no more than 25 to 30 gpm with a drawdown of 100 feet.

13. Some wells that are pumped heavily tend to decline gradually in yield. This fact may be due to the following circumstances. The size and setting of a pump are determined from a short bailer or pumping test when the well is completed. Such a short test may not indicate the long-term yield of the well because the first water is withdrawn form storage in the rock materials, and many hours, days, or even months may pass before there is a stable adjustment between the amount of water that the fractures can feed into the well and the amount of water available to drain through the overlying clay into the fractures feeding the well. Failure to have knowledge of water-level fluctuations as a result of pumping is the cause of many well problems and of the erroneous conclusion that well supplies are not dependable. If a well tends to have an unstable yield, it is probably overpumped. A reduction in the rate of pumping and consequently a raising of the water level will result in a perennially safe yield. Constant pumping at a moderate rate does not damage a well.

14. There is a tendency for rocks underlying a light-colored soil to yield water that is low in dissolved mineral matter and is soft. On the other hand, rocks underlying darker soils (dark red, brown, and yellow) tend to yield water that is slightly hard, or hard, and that may contain objectionable amounts of iron.

15. Many people think that a shallow depth to the water table is an indication of a good yield of a potential well, but this is not a rule to follow. In fact, where the water table is only a few feet beneath the land surface on an upland area, the rock fractures may be so scarce that water may not be able to move downward in the rock; it is held near the ground surface and perhaps is shunted out to the land surface as a wet seepage spot on a steep slope.

16. There are many mistaken notions about the availability of ground water in the region. These notions arise from lack of knowledge of the occurrence and movement of ground water and of the behavior of wells. The common erroneous statement that a certain town in the region could not depend on well water stems from the existence of a limited number of wells; never has the underground reservoir beneath any town or city in the region been completely depleted of its water. There has been a tendency for towns of about 3,000 people to convert from well supplies to a treated surface-water supply; such conversion commonly occurs when the town requires more than 500,000 gallons of water per day, an amount which only a few wells in aggregate may not produce. Few towns have the experienced persons with diversified knowledge of wells and ground-water conditions to provide the good management comparable to that of municipal surface-water supplies.

SOURCES OF INFORMATION

There are many sources of information about ground-water conditions in specific parts of the region. At least one agency in each State has cooperated financially with the U.S. Geological Survey, and these agencies have contributed in some way to the results of this report. Further information about reports published or work in progress may be obtained from the district offices of the Geological Survey in each State or from the respective State cooperating agencies.

GROUND-WATER DATA FOR GEORGIA, 1987

U.S. GEOLOGICAL SURVEY

OPEN-FILE REPORT 88-323

GROUND-WATER DATA FOR GEORGIA, 1987

By C.N. Joiner, M.S. Reynolds, W.L. Stayton, and F.G. Boucher

---

U.S. GEOLOGICAL SURVEY

Open-File Report 88-323

Prepared in cooperation with the

GEORGIA DEPARTMENT OF NATURAL RESOURCES
ENVIRONMENTAL PROTECTION DIVISION
GEORGIA GEOLOGIC SURVEY

Doraville, Georgia

1988

2.2 Crystalline Rock Aquifers

Although individual crystalline rock aquifers are not laterally extensive; collectively they yielded an estimated 91 Mgal/d in 1985 (Turlington and others, 1987), primarily for rural supply. Ground-water storage occurs in unconsolidated material overlying the crystalline rock and in joints, fractures, and other types of secondary openings within the rock (Cressler and others, 1983).

Ground-water levels in the crystalline rock aquifers are affected mainly by precipitation and evapotranspiration. Rainfall in the area is heavy in winter and midsummer and relatively light in spring and fall. The driest season of the year is fall. Ground-water levels rise rapidly with the onset of late winter rains and reduced evapotranspiration, and generally reach their highest levels for the year in March or April. Increases in evapotranspiration and decreases in rainfall during the spring and early summer cause ground-water levels to decline. Heavy rainfall in midsummer results in small rises in ground-water levels, but a lack of recharge in the fall causes water levels to decline to the annual lows, which generally occur in October or November.

During 1987, the mean water levels at wells 10DD02 in Fulton County, 11FF04 in DeKalb County, and 19HH12 in Madison County were from 0.2 to 1.3 ft higher in 1987 than in 1986. By the end of March, water levels in the wells had recovered 1.5 to 4.8 ft from the record lows measured during the 1986 drought. However, a new record low was measured at well 10DD02 in early December. The decline was in response to local pumping at the end of 1987, and water levels were from about the same to 1.6 ft lower than at the end of 1986.

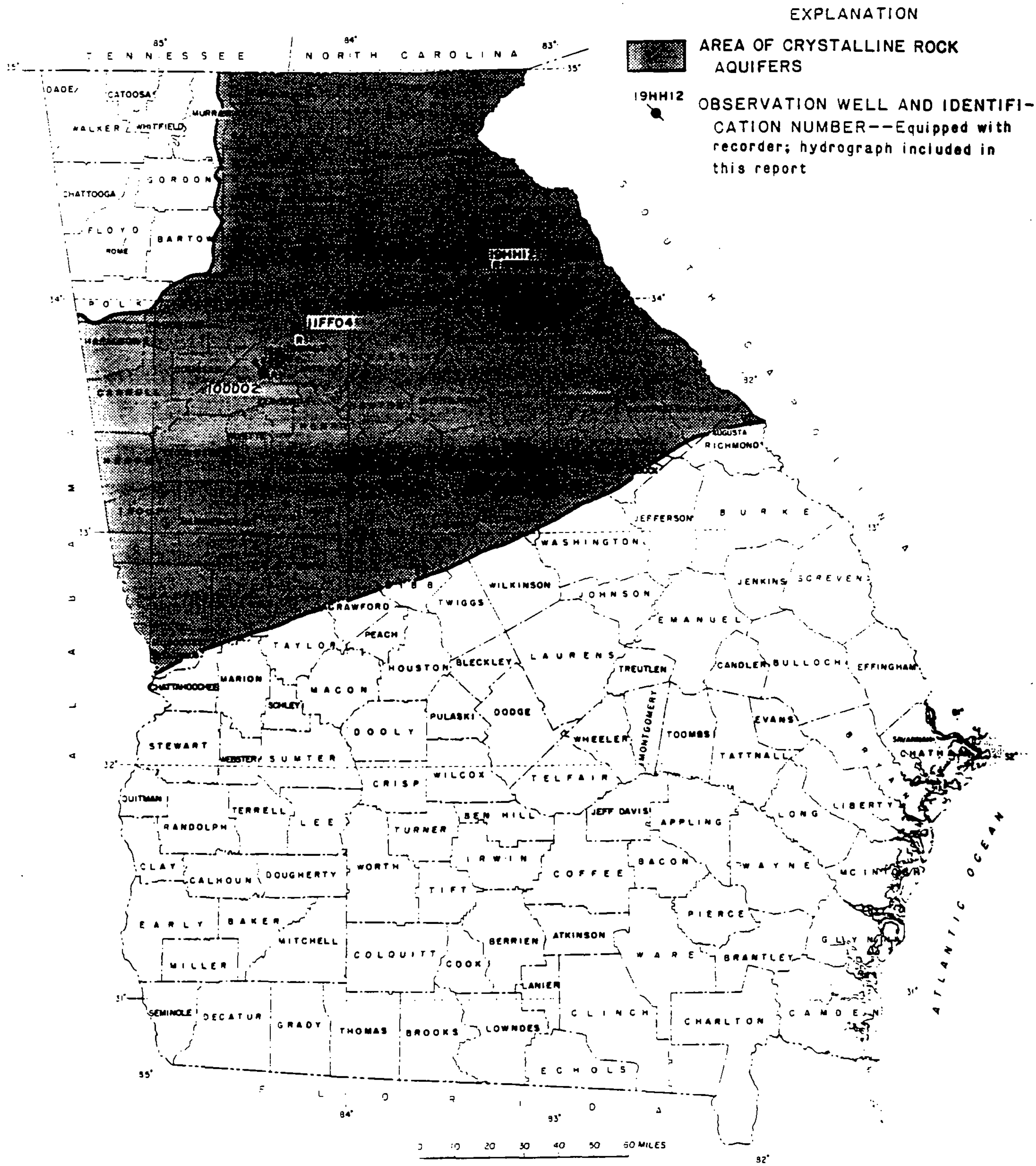
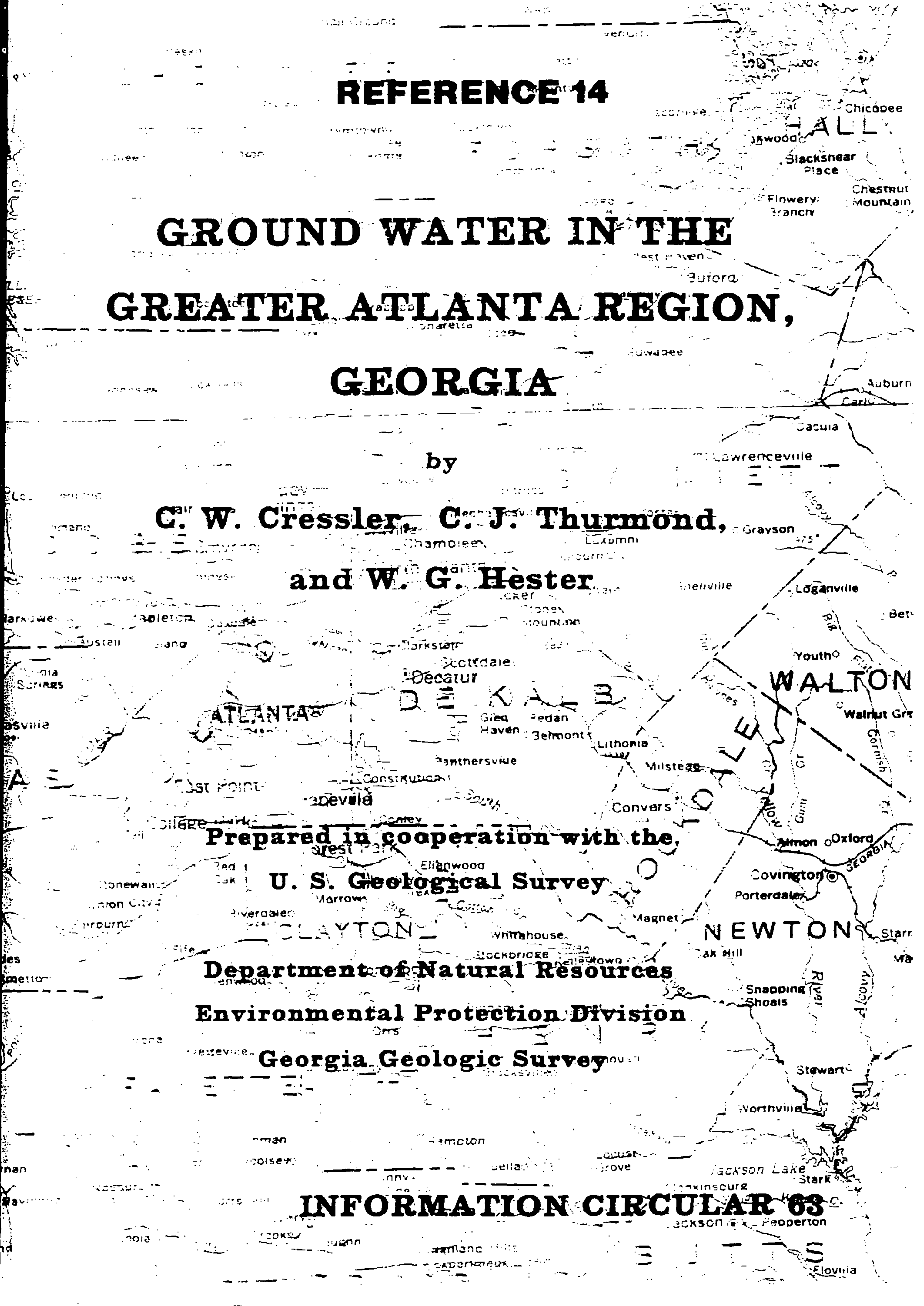


Figure 2.2-1.—Location of observation wells in the crystalline rock aquifers.



REFERENCE 14

GROUND WATER IN THE GREATER ATLANTA REGION, GEORGIA

by

C. W. Cressler, C. J. Thurmond, and W. G. Hester

Prepared in cooperation with the U. S. Geological Survey

Department of Natural Resources
Environmental Protection Division
Georgia Geologic Survey

INFORMATION CIRCULAR 63

GROUND WATER

IN THE GREATER ATLANTA REGION,

GEORGIA

By

C. W. Cressler, C. J. Thurmond, and W. G. Hester

Georgia Department of Natural Resources

Joe D. Tanner, Commissioner

Environmental Protection Division

J. Leonard Ledbetter, Director

Georgia Geologic Survey

William H. McLemore, State Geologist

Prepared in cooperation with the

U.S. Geological Survey

Atlanta

1983

INFORMATION
CIRCULAR 63

TABLE OF CONTENTS

LIST OF ILLUSTRATIONS

GROUND WATER IN THE GREATER ATLANTA REGION, GEORGIA

By C. W. Cressler, C. J. Thurmond, and W. G. Hester

ABSTRACT

The Greater Atlanta Region encompasses about 6,000 square miles in the Piedmont physiographic province of west-central Georgia. Municipal and industrial water supplies in the area are derived mainly from surface water taken from rivers, streams, and impoundments. Large withdrawals now and predicted for the future are causing concern about surface-water sources being able to meet the rising demands. This study was conducted to assess the availability of ground water in the crystalline rocks of the area, and to devise methods for locating sites for high-yielding wells that could provide alternative sources of supply.

The Greater Atlanta Region is roughly divided in half by the Chattahoochee River, which follows a comparatively straight southwesterly course for nearly 110 miles across the area. Streams in the north half of the area, including the Chattahoochee River basin, mainly have rectangular and trellis drainage styles and clearly show the influence of geologic control. The topography and drainage are closely related to bedrock permeability and conventional methods for locating high-yielding well sites apply to most of the area. In contrast, the south half of the area has a superimposed dendritic drainage style in which streams developed more or less independently of the underlying geology. There, the topography and drainage are poorly related to bedrock permeability; many high-yielding wells occupy ridge crests, steep slopes, and bare-rock areas normally considered to be sites of low yield potential.

To better understand the occurrence of ground water in the area, detailed geologic studies were made of 1,051 high-yielding well sites. The results showed that large well yields are available only where aquifers have localized increases in permeability. This occurs mainly in association with certain structural and stratigraphic features, including: (1) contact zones between rocks of contrasting character and also within multilayered rock units, (2) fault zones, (3) stress relief fractures, (4) zones of fracture concentration, (5) small-scale geologic structures that localize drainage development, (6) folds that produce concentrated jointing, and (7) shear zones. Methods for selecting high-yielding well sites using these structural and stratigraphic features are outlined in the report.

Borehole geophysical techniques were used to study the nature of water-bearing openings. Sonic televiewer logs revealed that in several wells the water-bearing openings consist of horizontal or nearly horizontal fractures 1 to 8 inches in vertical dimension. The fractures were observed in granitic gneiss, biotite gneiss, gneiss interlayered with schist, and in quartz-mica schist. The writers believe the openings are stress relief fractures formed by the upward expansion of the rock column in response to erosional unloading. Core drilling at two well sites confirmed the horizontal nature of the fractures and showed no indication of lateral movement that would associate the openings with faulting.

Wells that derive water from horizontal fractures characteristically remain essentially dry during drilling until they penetrate one or two high-yielding fractures. The fractures are at or near the bottom of the wells. The high-yielding fractures are at or near the bottom of wells because: (1) the large yields were in excess of the desired quantity and, therefore, drilling ceased, or (2) in deep wells yielding 50 to 100 gal/min or more, the large volume of water from the fracture(s) "drowned out" the pneumatic hammers in the drill bits, effectively preventing deeper drilling. Twenty-five wells in the report area are known to derive water from bottom-hole

In table 7, which lists chemical analyses of well water, some wells retain numbers used in previous reports.

WATER-BEARING UNITS AND THEIR HYDROLOGIC PROPERTIES

The part of the GAR included in this study lies wholly within the Piedmont physiographic province (Clark and Zisa, 1976; Fenneman, 1938). The area is underlain by a complex of metamorphic and igneous rocks that have been divided by various workers into more than 50 named formations and unnamed mappable units. Individual rock units range in thickness from less than 10 ft to possibly more than 10,000 ft.

Regional stresses have warped the rocks into complex folds and refolded folds, and the sequence has been injected by igneous plutons and dikes and broken by faults. Erosion of these folded and faulted rocks produced the complex outcrop patterns that exist today. The large number of rock types in the area and their varied outcrop patterns greatly complicate the occurrence and availability of ground water in the area. Nevertheless, many of the more than 50 named formations and unnamed mappable units in the GAR are made up of rocks that have similar physical properties and yield water of comparable quantity and chemical quality. Thus, for convenience, the rocks in the report area have been grouped into nine principal water-bearing units and assigned letter designations. The areal distribution of the water-bearing units and their lithologies are shown on plate 1. Data on wells in the water-bearing units are summarized in tables 1-3.

OCCURRENCE AND AVAILABILITY OF GROUND WATER

Ground water in the GAR occupies joints, fractures, and other secondary openings in bedrock and pore spaces in the overlying mantle of residual material. Water recharges the underground

Table 1.—Summary of well data for the Greater Atlanta Region

Water-bearing unit	Number of wells	Yield (gal/min)		Depth (ft)		Casing depth (ft)		Topography (percent of wells in each setting)						
		Range	Average	Range	Average	Range	Average	Slope	Broad lowlands	Uplands-ridge crests	Draw, hollow	Stream or lake	Saddle	Other
A Amphibolite-gneiss-schist	385	20-275	56	35-2,175	294	0-200	60	22	35	22	4	11	2	4
B Granitic gneiss	166	20-348	72	40-825	271	3-266	54	33	45	2	14	6	0	0
C Schist	185	20-150	47	67-700	195	4-144	53	19	19	27	20	11	4	0
D Biotite gneiss	70	20-351	56	82-710	270	7-140	56	20	27	36	6	11	0	0
E Mafic	32	20-471	79	67-386	191	8-116	46	17	35	28	3	17	0	0
F Granite	43	20-150	43	43-422	192	11-187	57	30	30	15	15	10	0	0
G Cataclastic	55	20-225	74	110-800	323	8-207	84	4	75	15	4	2	0	0
H Quartzite	12	20-200	72	122-500	297	30-85	58	45	9	27	18	0	0	0
J Carbonate	3	31-150	76	240-505	376	28-314	138	0	100	0	0	0	0	0

openings by seeping through this material or by flowing directly into openings in exposed rock. This recharge is from precipitation that falls in the area.

Unweathered and unfractured bedrock in the report area has very low porosity and permeability. Thus, the quantity of water that a rock unit can store is determined by the capacity and distribution of joints, fractures, and other types of secondary openings. The quantity of stored water that can be withdrawn by wells depends largely on the extent to which the rock openings are interconnected.

The size, spacing, and interconnection of openings differ greatly from one type of rock to another and with depth below land surface. Open joints and fractures tend to become tighter and more widely spaced with increasing depth. Joints and other openings in soft rocks such as phyllite tend to be tight and poorly connected; wells in rocks of this character generally have small yields. On the other hand, openings in more brittle rocks such as quartzite and graywacke tend to be larger and are better connected; wells in these rocks normally supply greater yields. Other rocks, including amphibolite, schist, and gneiss, are variable in the size and connection of secondary openings and generally yield small to moderate quantities of water to wells. Carbonate rocks, which include marble, can contain much larger and more extensively interconnected fracture systems. Openings in carbonate rocks commonly are enlarged by solution, and are capable of transmitting large quantities of water.

Effects of Drainage Style

The GAR is divided nearly in half by the Chattahoochee River, which follows a comparatively straight southwesterly course for nearly 110 miles across the area (fig. 1). Streams in the north half of the area, including the Chattahoochee River and its tributaries, mainly have rectangular and trellis drainage styles. In contrast, streams in the south half of the area, beginning at about the south edge of the Chattahoochee River basin, have a dendritic drainage style (Staheli, 1976).

Streams having rectangular drainage style flow in strongly angular courses that follow the rectangular pattern of the joints that break up the rocks. Areas having trellis drainage style are characterized by strongly folded and dipping rocks; the larger streams follow the outcrops of less resistant rocks and tributaries enter at right angles across the dip of the strata (Lobeck, 1939, p. 175). All of the streams in the north half of the area show the influence of geologic control, their drainage styles reflecting the varied outcrop pattern, the different lithologies present, and the geologic structure.

In the south half of the area, the dendritic drainage style is indicative of streams that developed independently of the underlying geology (LaForge and others, 1925; Staheli, 1976). According to Staheli (1976, p. 451), dendritic drainage, in which streams run in all directions like the branches of a tree, probably was established on some pre-existing surface and later superimposed on the underlying crystalline rocks. Such streams are said to be superimposed when they acquire a course on nearly flat-lying material that covered the rocks beneath. Streams flowing on the veneer of material that covers the bedrock are superimposed above the concealed rocks. When rejuvenated by uplift, they become incised and develop courses without regard to the structure or lithology of the underlying rocks. Eventually, the cover material may be entirely removed and then only the physiographic pattern of the streams will suggest their having been let down from a superimposed position (Lobeck, 1939, p. 173).

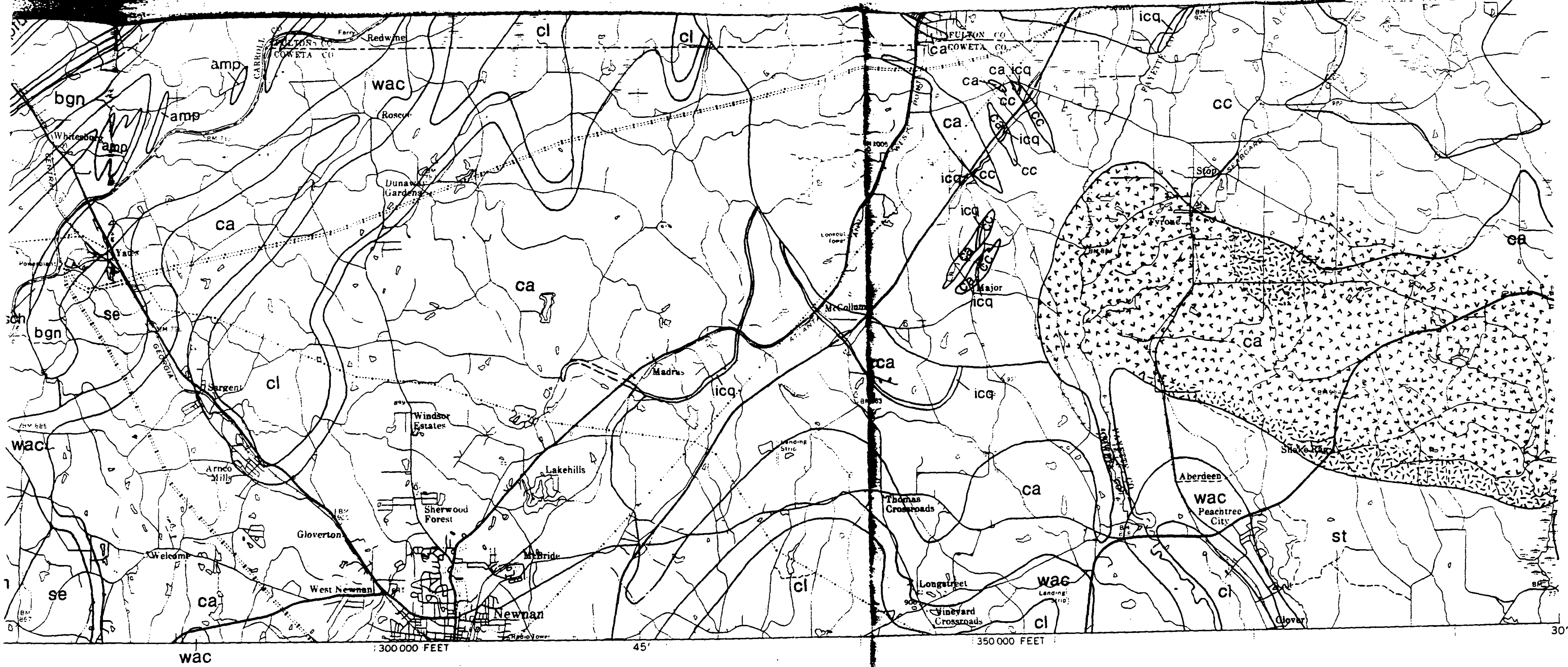
According to Staheli (1976, p. 451), to explain the different drainage styles in regions underlain by similar rocks and structures, it is suggested that an earlier Coastal Plain sedimentary cover buried the Piedmont and extended inland at least to the Chattahoochee River valley. Thus, according to Staheli, drainage to the north developed originally on Piedmont rocks and so reflects their structural orientations. Staheli believes that streams south of the Chattahoochee River valley developed as consequent streams on a flat Coastal Plain cover. These streams extended headward as sea levels lowered, developed dendritic drainage, and eventually became superimposed across regional Piedmont structures. Thus, the general area of the Chattahoochee River valley might well coincide with a fossil Fall Line in Georgia (Staheli, 1976, p. 451). As Staheli points out, in areas near the Chattahoochee River, the drainage pattern suggests that higher, more resistant rocks could have existed as islands that locally controlled stream development even though the lower areas were covered by Coastal Plain sediment. For example, drainage obviously has been diverted by such prominences as Stone Mountain.

Observations made during the present study indicate that in the south half of the GAR, many of the smaller elements of the drainages, such as draws, hollows, and intermittent streams in the uppermost headwaters areas seem to have developed under geologic control. The presence of geologic control is indicated by smaller drainages that parallel prominent joint sets or that are alined with bedrock foliation. Presumably these late-forming drainages were established after removal of a preexisting cover and, therefore, developed under geologic control. The fact that the smaller drainages may reflect bedrock weaknesses, whereas the larger streams generally may not, has a profound influence on the occurrence of ground water in the south half of the GAR and on the methods that can be used successfully to locate large ground-water supplies. The relations between drainage styles and the occurrence of ground water, and the effects that drainage styles have on the methods that can be used to locate sites for high-yielding wells, are discussed in later sections of this report.

AVAILABILITY OF LARGE GROUND-WATER SUPPLIES

The quantity of ground water available in the GAR varies greatly with the location, rock type, topographic setting, drainage style, and the geologic structure. In some areas, most wells yield less than 3 gal/min, which generally is considered a minimum requirement for domestic and stock supplies. In more favorable areas, yields commonly range between 3 and 10 gal/min. It should be pointed out, however, that obtaining this quantity may require drilling in more than one site.

High-yielding wells--ones that supply 20 gal/min or more--generally can be developed only where the rocks possess localized increases in permeability. This occurs mainly in association with certain structural and stratigraphic features, including: (1) contact zones between rock units of contrasting character, (2) contact zones within multilayered rock units, (3) fault zones, (4) stress-relief fractures, (5) zones of fracture concentration, (6) small-scale structures, including joints, foliation planes, and fold axes, that localize drainage development, (7) folds that produce concentrated jointing, and (8) shear zones. Other factors, such as topographic setting, drainage style, rock type, depth of weathering, thickness of soil cover, and the pervasiveness and orientation of foliation can interact to increase or decrease the availability of ground water. The nature and occurrence of structural and stratigraphic features known to increase bedrock permeability, and the relation of these features to drainage style, topography, and other factors, are discussed in the following sections.



: GREATER ATLANTA REGION

K. I. McConnell and C. E. Abrams

SCALE 1:100,000

0 1 2 3 4 5 MILES

0 1000 2000 3000 4000 5000 FEET

0 1 2 3 4 5 KILOMETERS

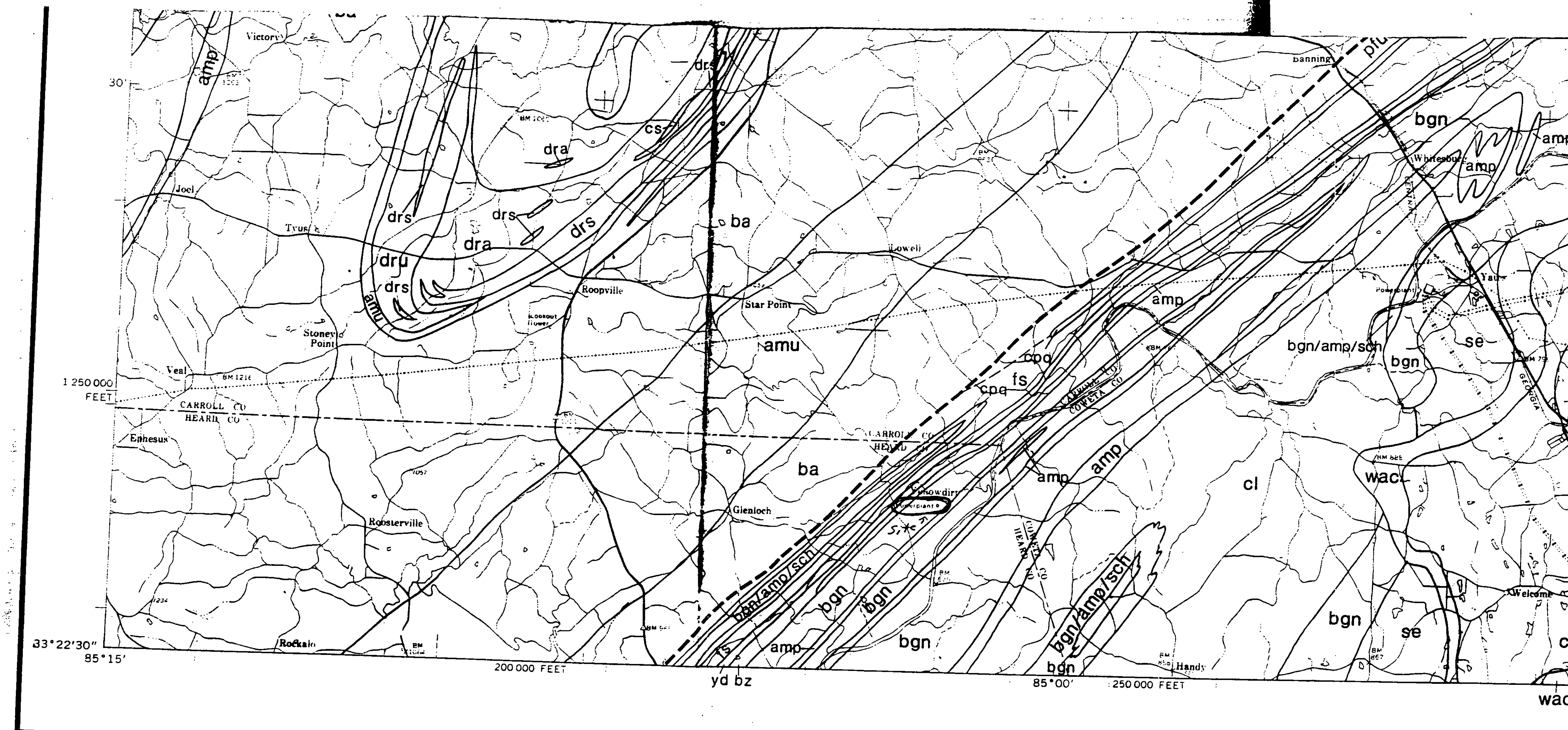
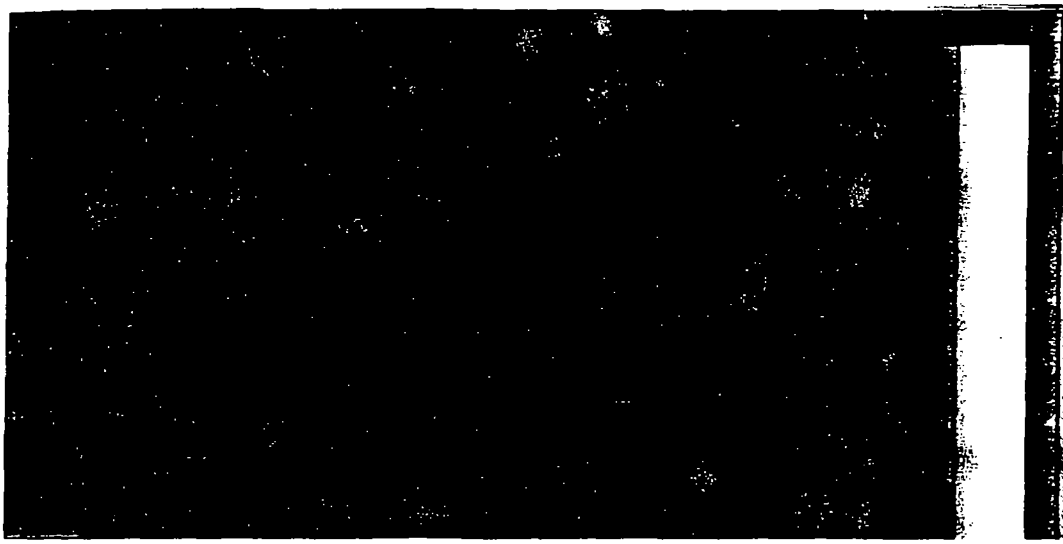


Plate I West, Bulletin 96

GEOLOGY OF THE GREATE

Compiled by K. I. McConnell a

REFERENCE 15



R. Allan Freeze

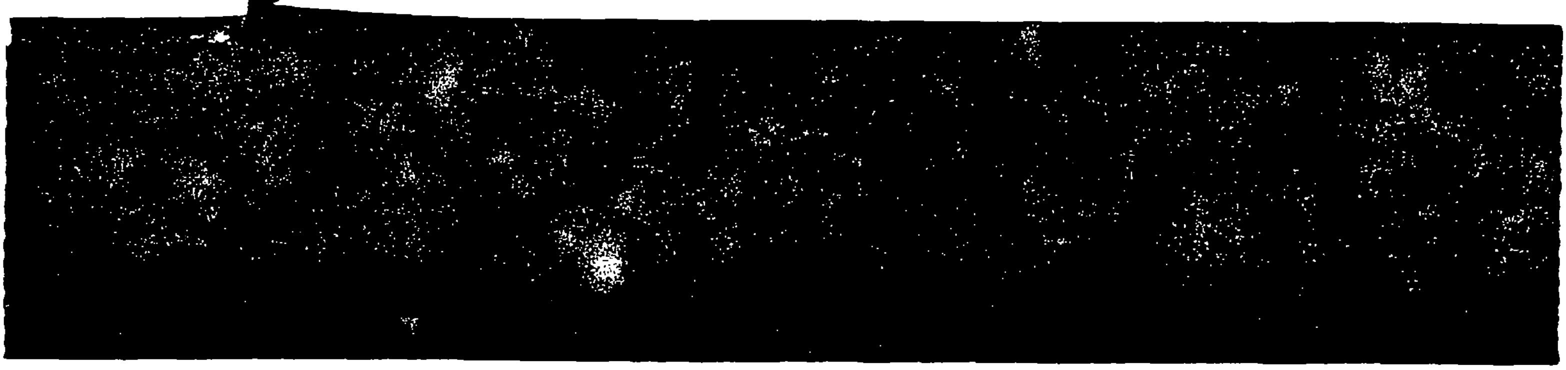
Department of Geological Sciences
University of British Columbia
Vancouver, British Columbia

John A. Cherry

Department of Earth Sciences
University of Waterloo
Waterloo, Ontario

GROUNDWATER

Prentice-Hall, Inc.
Englewood Cliffs, New Jersey 07632



If a temperature gradient can cause fluid flow as well as heat flow in a porous medium, it should come as no surprise to find that a hydraulic gradient can cause heat flow as well as fluid flow. This mutual interdependency is a reflection of the well-known thermodynamic concept of *coupled flow*. If we set $dh/dl = i_1$ and $dT/dl = i_2$, we can write a pair of equations patterned after Eq. (2.22):

$$v_1 = -L_{11}i_1 - L_{12}i_2 \tag{2.23}$$

$$v_2 = -L_{21}i_1 - L_{22}i_2 \tag{2.24}$$

where v_1 is the specific discharge of *fluid* through the medium and v_2 is the specific discharge of *heat* through the medium. The L's are known as *phenomenological coefficients*. If $L_{12} = 0$ in Eq. (2.23), we are left with Darcy's law of groundwater flow and L_{11} is the hydraulic conductivity. If $L_{21} = 0$ in Eq. (2.24), we are left with Fourier's law of heat flow and L_{22} is the thermal conductivity.

It is possible to write a complete set of coupled equations. The set of equations would have the form of Eq. (2.23) but would involve all the gradients of Eq. (2.21) and perhaps others. The development of the theory of coupled flows in porous media was pioneered by Taylor and Cary (1964). Olsen (1969) has carried out significant experimental research. Bear (1972) provides a more detailed development of the concepts than can be attempted here. The thermodynamic description of the physics of porous media flow is conceptually powerful, but in practice there are very few data on the nature of the off-diagonal coefficients in the matrix of phenomenological coefficients L_{ij}. In this text we will assume that groundwater flow is fully described by Darcy's law [Eq. (2.3)]; that the hydraulic head [Eq. (2.18)], with its elevation and pressure components, is a suitable representation of the total head; and that the hydraulic conductivity is the only important phenomenological coefficient in Eq. (2.21).

2.3 Hydraulic Conductivity and Permeability

As Hubbert (1956) has pointed out, the constant of proportionality in Darcy's law, which has been christened the hydraulic conductivity, is a function not only of the porous medium but also of the fluid. Consider once again the experimental apparatus of Figure 2.1. If Δh and Δl are held constant for two runs using the same sand, but water is the fluid in the first run and molasses in the second, it would come as no surprise to find the specific discharge v much lower in the second run than in the first. In light of such an observation, it would be instructive to search for a parameter that can describe the conductive properties of a porous medium independently from the fluid flowing through it.

To this end experiments have been carried out with ideal porous media consisting of uniform glass beads of diameter d. When various fluids of density ρ and dynamic viscosity μ are run through the apparatus under a constant hydraulic gradient dh/dl, the following proportionality relationships are observed:

$$v \propto d^2$$

$$v \propto \rho g$$

$$v \propto \frac{1}{\mu}$$

Together with Darcy's original observation that $v \propto -dh/dl$, these three relationships lead to a new version of Darcy's law:

$$v = -\frac{Cd^2\rho g}{\mu}\frac{dh}{dl} \tag{2.25}$$

The parameter C is yet another constant of proportionality. For real soils it must include the influence of other media properties that affect flow, apart from the mean grain diameter: for example, the distribution of grain sizes, the sphericity and roundness of the grains, and the nature of their packing.

Comparison of Eq. (2.25) with the original Darcy equation [Eq. (2.3)] shows that

$$K = \frac{Cd^2\rho g}{\mu} \tag{2.26}$$

In this equation, ρ and μ are functions of the fluid alone and Cd^2 is a function of the medium alone. If we define

$$k = Cd^2 \tag{2.27}$$

then

$$K = \frac{k\rho g}{\mu} \tag{2.28}$$

The parameter k is known as the ***specific*** or ***intrinsic permeability***. If K is always called hydraulic conductivity, it is safe to drop the adjectives and refer to k as simply the permeability. That is the convention that will be followed in this text, but it can lead to some confusion, especially when dealing with older texts and reports where the hydraulic conductivity K is sometimes called the *coefficient of permeability*.

Hubbert (1940) developed Eqs. (2.25) through (2.28) from fundamental principles by considering the relationships between driving and resisting forces on a microscopic scale during flow through porous media. The dimensional considerations inherent in his analysis provided us with the foresight to include the constant g in the proportionality relationship leading to Eq. (2.25). In this way C emerges as a dimensionless constant.

The permeability k is a function only of the medium and has dimensions $[L^2]$. The term is widely used in the petroleum industry, where the existence of gas, oil, and water in multiphase flow systems makes the use of a fluid-free conductance parameter attractive. When measured in m^2 or cm^2, k is very small, so petroleum engineers have defined the *darcy* as a unit of permeability. If Eq. (2.28) is substituted in Eq. (2.3), Darcy's law becomes

$$v = \frac{-k\rho g}{\mu}\frac{dh}{dl} \tag{2.29}$$

Referring to this equation, 1 darcy is defined as the permeability that will lead to a specific discharge of 1 cm/s for a fluid with a viscosity of 1 cp under a hydraulic gradient that makes the term $\rho g\, dh/dl$ equal to 1 atm/cm. One darcy is approximately equal to 10^{-8} cm^2.

In the water well industry, the unit gal/day/ft^2 is widely used for hydraulic conductivity. Its relevance is clearest when Darcy's law is couched in terms of Eq. (2.4):

$$Q = -K\frac{dh}{dl}A$$

The early definitions provided by the U.S. Geological Survey with regard to this unit differentiate between a laboratory coefficient and a field coefficient. However, a recent updating of these definitions (Lohman, 1972) has discarded this formal differentiation. It is sufficient to note that differences in the temperature of measurement between the field environment and the laboratory environment can influence hydraulic conductivity values through the viscosity term in Eq. (2.28). The effect is usually small, so correction factors are seldom introduced. It still makes good sense to report whether hydraulic conductivity measurements have been carried out in the laboratory or in the field, because the methods of measurement are very different and the interpretations placed on the values may be dependent on the type of measurement. However, this information is of practical rather than conceptual importance.

Table 2.2 indicates the range of values of hydraulic conductivity and permeability in five different systems of units for a wide range of geological materials. The table is based in part on the data summarized in Davis' (1969) review. The primary conclusion that can be drawn from the data is that hydraulic conductivity varies over a very wide range. There are very few physical parameters that take on values over 13 orders of magnitude. In practical terms, this property implies that an order-of-magnitude knowledge of hydraulic conductivity can be very useful. Conversely, the third decimal place in a reported conductivity value probably has little significance.

Table 2.3 provides a set of conversion factors for the various common units of k and K. As an example of its use, note that a k value in cm^2 can be converted to one in ft^2 by multiplying by 1.08×10^{-3}. For the reverse conversion from ft^2 to cm^2, multiply by 9.29×10^2.

: conductance
so petroleum
is substituted

(2.29)

ıt will lead to
:r a hydraulic
:y is approxi-

for hydraulic
ı terms of Eq.

regard to this
:nt. However,
:d this formal
re of measure-
can influence
). The effect is
makes good
: been carried
:ment are very
:ndent on the
her than con-

ty and perme-
ical materials.
ı) review. The
c conductivity
's that take on
:y implies that
ıe very useful.
: probably has

common units
ıe converted to
on from ft² to

Table 2.2 Range of Values of Hydraulic Conductivity and Permeability

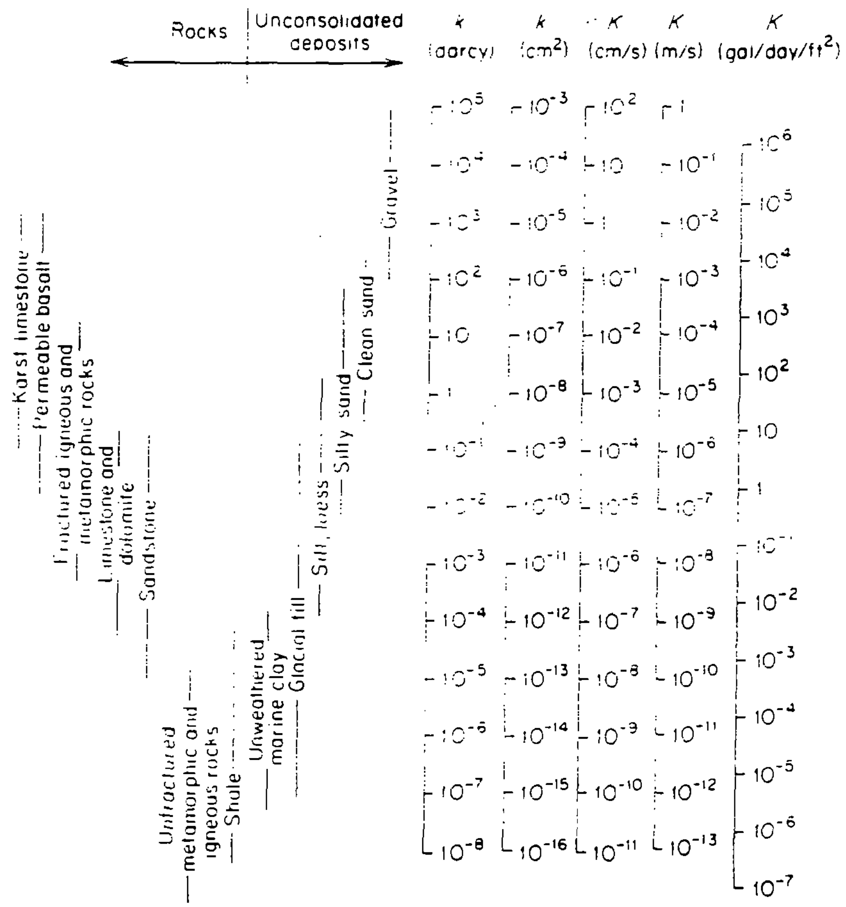


Table 2.3 Conversion Factors for Permeability and Hydraulic Conductivity Units

	Permeability, k*			Hydraulic conductivity, K		
	cm²	ft²	darcy	m/s	ft/s	U.S. gal/day/ft²
cm²	1	1.08×10^{-3}	1.01×10^{8}	9.80×10^{2}	3.22×10^{3}	1.85×10^{9}
ft²	9.29×10^{2}	1	9.42×10^{10}	9.11×10^{5}	2.99×10^{6}	1.71×10^{12}
darcy	9.87×10^{-9}	1.06×10^{-11}	1	9.66×10^{-6}	3.17×10^{-5}	1.82×10^{1}
m/s	1.02×10^{-3}	1.10×10^{-6}	1.04×10^{5}	1	3.28	2.12×10^{6}
ft/s	3.11×10^{-4}	3.35×10^{-7}	3.15×10^{4}	3.05×10^{-1}	1	6.46×10^{5}
U.S. gal/day/ft²	5.42×10^{-10}	5.83×10^{-13}	5.49×10^{-2}	4.72×10^{-7}	1.55×10^{-6}	1

*To obtain k in ft², multiply k in cm² by 1.08×10^{-3}.

REFERENCE 16

LOGBOOK REQUIREMENTS
REVISED - NOVEMBER 29, 1988

NOTE: ALL LANGUAGE SHOULD BE FACTUAL AND OBJECTIVE

1. Record on front cover of the Logbook: TDD No., Site Name, Site Location, Project Manager
2. All entries are made using ink. Draw a single line through errors. Initial and date corrections.
3. Statement of Work Plan, Study Plan, and Safety Plan discussion and distribution to field team with team members' signatures
4. Record weather conditions and general site information
5. Sign and date each page. Project Manager is to review and sign off on each logbook daily
6. Document all calibration and pre-operational checks of equipment. Provide serial numbers of equipment used onsite.
7. Provide reference to Sampling Field Sheets for detailed sampling information
8. Describe sampling locations <u>in detail</u> and document all changes from project planning documents.
9. Provide a site sketch with sample locations and photo locations
10. Maintain photo log by completing the stamped information at the end of the logbook
11. If no site representative is on hand to accept the receipt for samples, an entry to that effect must be placed in the logbook.
12. Record I.D. numbers of COC and receipt for sample forms used. Also record numbers of destroyed documents
13. Complete SMO information in the space provided.

The undersigned have read and understand the Study Plan, Site Safety Plan & Scope of this project.

John Jenkins

J. Jay Chester

Andy Spangler

Wendell Hilander

9/17/90 Clear & cool - Temp in the mid 80's

2:00 Arrived at facility & signed in.
Met with Randy Turner and the following other GA Power Representatives
Alan Reeves
C.L. Kennedy
Mark Mitchell
M Sump
S.A. Rogers
ABC Jiles
& C.E Taylor

9/17/90

Randy Turner informed me that where the study plan identifies GP-SD(SW)-06 there is no overflow from ash pond into the storage water pond. We will not collect a sample here or at the confluence of Yellow Dirt creek & the Chattahoochee River

3:50 Andy Sprague, Jay Claughton & John Jenkins collected GP-SW-01 from Yellow Dirt Creek

3:55 same crew collected GP-SD-01 from same location

9/17/90

1635 Jenkins & Christensen collected GP SS-01 at facility retention area ≈ 45' N of facility well

1640 Andy Sprigle collected TW-401 from rec area well - duplicate MATRIX

	cond	temp	ph
1630	67	17°	6.7
1635	58	18°	6.6
1640	57	18°	6.5

[illegible] 9/17/90

1740 Christensen & Jenkins collected GP SW-02 at boat ramp upstream of facility at plant intake

1745 same crew collected matrix sed GP SD-02 at same location as SW-02

1855 left site

[illegible] 9/17/90

6

9/18/90 Clear & cool

0817 Arrived at site & began setting up CP & Decon Line. Andy calibrated instrument [illegible]

0910 Andy, Sprague & Jay Chaslaw collected GP-SB-01 at 5' BLS in the same location as GP-SS-01. Dark brown loamy soil. Mostly [illegible]

0935 Sprague & Jenkins collected GP-SD-01 at confluence of NPDES discharge & the Chattahoochee River.

JJ 9/18/90

0955 Sprague & Jenkins collected GP-SD-02 [illegible] from same location [illegible] red [illegible] mud

1010 [illegible] GP-SB-03 [illegible] soil [illegible] holding retention pond [illegible] dike [illegible] adjacent to a creek bed leading from the retention pond to [illegible]

1055 Jenkins & Chaslaw collected GP-SB-03 from south side of retention pond dike adjacent to creek bed @ 3.5' bls. (there is water standing not flowing in the creek bed)

JJ 9/18/90

1120 [illegible] collected
GP-[illegible] 05 [illegible]
[illegible]

1140 [illegible] collected
GP-[illegible] 05 [illegible]
[illegible]
[illegible]
[illegible]

1150 [illegible] collected
[illegible]
[illegible]

1200 [illegible] collected
GP-SB-[illegible]

9/13/90

	SW-02	SW-04	SW-03	SW-05	SW-10
Cond	107	1317	291	235	126
Temp	6.3	7.6	5.8	7.2	7.1
pH	24°C	29°C	[illegible]	30°C	30°C

1405 ME Sloop of GM power signed [illegible] samples

1445 Chas[illegible] & Sp[illegible] collected GP-SB-04 [illegible] south end & ≈ 30 from [illegible] ≈ 35 from edge of woods ≈ 12" deep

1520 Spangle & Cha[illegible] collected GP-710-04 at 14" BLSD collected at same location as GP-SB-04

	pH	Cond	Temp
GP [illegible] 04		23	
GP [illegible] 11	6.6	50	[illegible]

1605 collected [illegible] GP-SW-11 at creek south of [illegible]

9/13/90

1645 Speight, Chastain & Jenkins collected GP SW-06 from coal [illegible] pile runoff pond

1650 collected sediment GP SD-06 at [illegible] [illegible] GP SW-06 [illegible] blank sample

1700 Jenkins, Speight & Chastain collected GP SW-07 from the [illegible] coal pile runoff pond

1720 Jenkins, Speight & Chastain collected GP SD-07 at same location as GP SW-07, blanks [illegible] collected

6/15/90

	pH	Cond	Temp
GP SW-06	3.1	1111	29°C
GP SW-07	4.5	467	[illegible]°C

1815 M.E. Sharp signed receipt for sample forms

1845 left site

6/15/90

9/19/90

[illegible] Arrived at site
clear & cool
we began setting up the
GT

0815 John Jenkins calibrated
HNu

[illegible] [illegible] [illegible] GT-BC5
[illegible] (USD) brown [illegible] sand & wet clay located close
south of large construction landfill
we augered down to 20' bls & could not obtain water so we will not collect GT-[illegible]

9/19/90

1040 Began drilling hole for GT-SB-02 & refusal at 10.5' bls. Reset adjacent to hole ≈ 6' bls & collected

1050 Collected GT-SB-02 collected by Jenkins, Spaugh & Chastain. Sample located adjacent to NE corner of small construction landfill
we are unable to obtain water here so GT-TW-02 will not be collected

9/19/90

[illegible] Jenkins [illegible] collected [illegible] SE corner [illegible] pond [illegible] collected [illegible] BGS [illegible]

1300 we continued drilling for water but had refusal at 20' blsd. After [illegible] well [illegible] TP [illegible] day again

[illegible] began collecting sample GT-BTW-01 across [illegible] tracks from NE corner of [illegible] pond [illegible] drilled to 15' BLSD collected at 15' BLSD collected by Jenkins / Chastain

[illegible] completed [illegible]

[illegible] 9/19/90

	pH	cond	temp
TW-01	4.31	832	28 [illegible]

[illegible] clean CP - [illegible] equipment

1850 left site

[illegible] 9/19/90

[illegible]

[illegible]

0830 [illegible]

0915 collected soil 09 from SE corner of Ash Pond

0930 collected [illegible]

[illegible]

[illegible] 9/20/90

[illegible]

	Temp	cond	pH
SP-SO-03	[illegible]	[illegible]	6.97
SP-SO-09	[illegible]	617	7.97

pH & cond meter [illegible] working properly so the facility provided this information via their laboratory

9/20/90

15

1:50 Charlie J. [illegible] collected [illegible] of [illegible] [illegible]

11:[illegible] [illegible] collected [illegible] of [illegible] black [illegible]

JJ 9/10/10

1:07 Carolyn Kennedy ~~[illegible] Sloop~~ Signed receipt of samples

1:30 Met w/ [illegible] Ellis, Asst Mgr of operations Exit meeting

Liberty Church [illegible] has written [illegible] its [illegible] provided by [illegible] water system - according to [illegible] Times.

JJ. 9/20/10

19

20

N/20/92

21

Organic lab - WANTEC (ECOTEK)
ATLANTA, GA

Case No. 14890

Low Concentration yes/no Inorganic lab - Skinner & Sherman
Waltham, MA

Organics

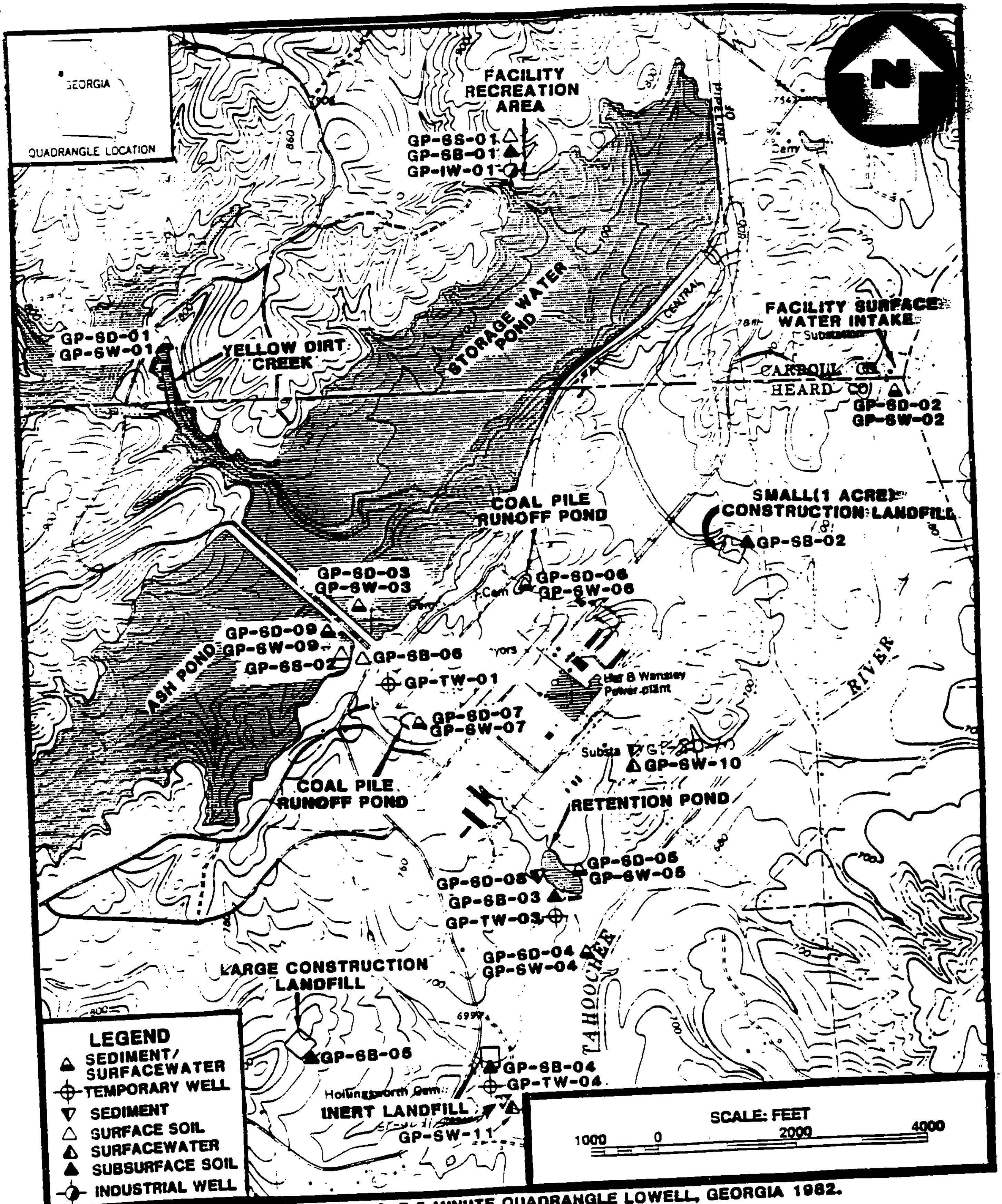
	Media	Lab	Airbill No
	Soil		
	Water		

Inorganics

	Media	Lab	Airbill No
	Soil		
	Water		

Keyed to map

By Whom



BASE MAP IS A PORTION OF THE U.S.G.S. 7.5 MINUTE QUADRANGLE LOWELL, GEORGIA 1982.

SAMPLE LOCATION MAP
GEORGIA POWER-PLANT WANSLEY
ROOPVILLE, HEARD COUNTY, GEORGIA

FIGURE 3

NUS CORPORATION

U.S. Department of Commerce, Proof Copy of table generated for 1990 CPH-1: Summary Population and Housing Characteristics, issued by Bureau of the Census (April 1991).

REFERENCE 17

Table 6. Household, Family, and Group Quarters Characteristics: 1990

(For definitions of terms and meanings of symbols, see text)

State / County / Place and [In Selected States] County Subdivision	Persons in households	All households	Family households: Total	Family households: Married-couple family	Family households: Female householder, no husband present	Nonfamily households: Total	Householder living alone: Total	65 years and over: Total	65 years and over: Female	Persons per — Household	Persons per — Family	Persons in group quarters: Total	Institutionalized persons	Other persons in group quarters
The State	6 304 993	2 366 615	1 713 072	1 306 798	329 641	653 543	537 792	186 667	148 417	2.66	3.16	173 653	87 266	86 387
COUNTY														
Appling County	15 580	5 634	4 275	3 423	687	1 559	1 433	686	535	2.67	3.21	164	164	-
Atkinson County	6 209	2 210	1 647	1 299	284	563	517	282	229	2.81	3.33	4	4	-
Bacon County	9 438	3 442	2 645	2 200	339	797	742	378	301	2.74	3.17	130	121	9
Baker County	3 610	1 300	949	666	220	351	326	174	148	2.78	3.33	5	5	-
Baldwin County	32 270	12 188	8 736	6 006	2 183	3 430	2 770	1 007	815	2.65	3.14	7 260	6 515	745
Banks County	10 292	3 778	2 973	2 563	283	802	724	353	281	2.73	3.13	16	16	-
Barrow County	29 486	10 678	8 381	6 828	1 149	2 315	2 018	941	785	2.76	3.15	232	209	23
Bartow County	55 465	20 091	15 665	12 826	2 146	4 426	3 861	1 605	1 328	2.76	3.17	426	366	60
Ben Hill County	15 923	5 972	4 343	3 153	1 007	1 629	1 509	764	620	2.67	3.22	322	282	70
Berrien County	13 656	5 140	3 950	3 208	568	1 190	1 105	530	427	2.66	3.13	294	109	185
Bibb County	145 108	56 307	39 301	28 742	10 753	17 006	14 982	5 916	4 812	2.58	3.14	4 888	2 904	1 985
Bleckley County	10 005	3 816	2 984	2 223	534	952	864	452	369	2.62	3.08	425	121	304
Brantley County	11 058	3 811	3 109	2 506	384	702	629	279	217	2.90	3.25	8	8	-
Brooks County	15 026	5 392	4 040	2 881	974	1 352	1 223	628	498	2.79	3.30	372	279	93
Bryan County	15 301	5 370	4 226	3 514	554	844	735	305	218	3.02	3.34	137	-	137
Bulloch County	39 458	14 284	9 685	7 449	1 782	5 299	3 480	1 293	1 042	2.63	3.15	3 687	687	3 000
Burke County	20 363	7 277	5 280	3 482	1 543	1 749	1 573	734	564	2.80	3.41	216	216	-
Butts County	13 557	4 606	3 607	2 922	566	999	872	404	308	2.90	3.31	1 799	1 683	116
Calhoun County	4 916	1 794	1 298	837	364	525	491	292	234	2.74	3.38	97	97	-
Camden County	27 328	9 459	7 472	6 152	1 003	1 987	1 609	415	311	2.89	3.28	2 839	139	2 700
Candler County	7 440	2 828	2 042	1 536	415	786	717	381	298	2.63	3.17	295	295	-
Carroll County	68 725	25 378	18 980	15 272	2 858	6 401	5 381	2 108	1 744	2.71	3.18	2 887	758	1 839
Catoosa County	42 108	15 748	12 388	10 301	1 621	3 379	3 003	1 308	1 098	2.67	3.08	386	336	50
Charlton County	8 384	2 811	2 257	1 748	407	654	573	249	190	2.88	3.32	112	112	-
Chatham County	209 677	81 111	56 590	40 828	12 987	24 551	21 036	8 128	6 444	2.58	3.14	7 288	3 966	3 322
Chattahoochee County	10 616	2 884	2 637	2 370	214	247	218	62	47	3.68	3.89	6 310	70	6 240
Chattooga County	22 050	8 467	6 393	5 041	1 070	2 074	1 819	1 039	843	2.61	3.08	183	183	-
Cherokee County	89 441	31 338	25 760	22 478	2 324	5 548	4 415	1 430	1 152	2.86	3.18	763	436	327
Clarke County	79 604	33 170	18 182	12 884	4 401	14 988	9 547	2 327	1 866	2.40	3.02	7 689	604	7 085
Clay County	3 287	1 210	874	556	254	336	318	182	134	2.72	3.30	77	74	3
Clayton County	180 488	65 523	48 734	37 000	9 218	16 789	13 005	2 382	1 935	2.75	3.19	1 569	1 248	317
Clinch County	6 034	2 173	1 655	1 257	313	518	478	208	170	2.78	3.25	126	96	30
Cobb County	444 691	171 288	120 113	98 988	15 518	51 175	39 537	6 828	5 634	2.60	3.10	3 086	1 970	1 076
Coffee County	29 015	10 541	7 981	6 025	1 614	2 580	2 319	1 038	841	2.75	3.22	577	237	340
Colquitt County	34 937	12 980	9 738	7 242	2 083	3 244	2 984	1 582	1 290	2.69	3.16	1 708	543	1 165
Columbia County	64 929	21 841	18 315	15 640	2 054	3 526	2 838	632	461	2.97	3.28	1 102	948	154
Cook County	13 172	4 825	3 607	2 788	648	1 218	1 116	589	469	2.73	3.22	284	128	156
Coweta County	53 381	18 930	15 020	11 807	2 482	3 910	3 394	1 449	1 188	2.82	3.20	472	456	16
Crawford County	8 820	3 080	2 412	1 898	396	667	577	238	178	2.87	3.29	182	108	74
Crisp County	19 986	7 287	5 300	3 588	1 491	1 987	1 808	878	717	2.69	3.23	412	408	4
Dade County	12 583	4 661	3 736	3 170	429	925	856	398	298	2.70	3.05	596	223	373
Dawson County	9 377	3 380	2 734	2 357	288	626	538	188	151	2.78	3.12	52	29	23
Decatur County	24 748	8 982	6 675	4 743	1 636	2 307	2 082	1 028	818	2.76	3.27	763	446	317
DeKalb County	536 484	228 888	137 608	98 641	31 277	71 087	52 646	11 729	9 738	2.37	3.12	10 389	6 380	4 009
Dodge County	16 627	6 307	4 607	3 550	853	1 700	1 600	844	684	2.60	3.12	888	888	-
Dooly County	9 728	3 587	2 592	1 779	683	973	913	509	413	2.74	3.31	171	148	23
Dougherty County	93 017	34 109	25 101	16 535	7 300	9 082	7 966	2 707	2 224	2.72	3.26	3 288	1 158	2 130
Douglas County	70 334	24 277	19 728	16 547	2 415	4 526	3 643	1 107	887	2.89	3.22	788	666	122
Early County	11 646	4 283	3 113	2 207	740	1 158	1 084	604	475	2.73	3.29	208	208	-
Echols County	2 319	816	664	548	78	162	153	63	46	2.84	3.20	15	-	15
Effingham County	25 636	8 790	7 140	5 881	989	1 610	1 422	580	430	2.92	3.28	51	51	-
Elbert County	18 634	7 115	5 314	4 079	1 008	1 801	1 680	883	719	2.62	3.10	319	283	36
Emanuel County	20 210	7 420	5 301	4 066	1 205	1 619	1 790	637	740	2.72	3.26	338	328	10
Evans County	8 374	3 144	2 284	1 671	514	860	781	381	300	2.66	3.19	350	319	31
Fannin County	15 653	6 324	4 644	4 128	528	1 480	1 401	753	580	2.50	2.88	128	120	8
Fayette County	62 210	21 054	18 018	16 110	1 436	3 036	2 640	1 001	826	2.95	3.23	187	187	-
Floyd County	77 938	30 518	22 518	17 744	3 882	8 000	7 203	3 508	2 891	2.56	3.02	3 282	1 697	1 585
Forsyth County	43 782	15 936	12 787	11 166	1 113	3 151	2 580	984	773	2.75	3.07	289	270	15
Franklin County	16 286	6 388	4 787	3 880	629	1 579	1 480	778	604	2.56	3.02	364	166	198
Fulton County	608 674	257 140	156 887	98 288	47 519	101 253	79 746	21 475	17 301	2.44	3.11	21 677	8 485	13 592
Gilmer County	13 179	5 072	3 940	3 382	464	1 132	1 036	543	437	2.60	2.99	189	189	-
Glascock County	2 243	887	649	541	94	218	198	98	72	2.50	3.06	114	114	-
Glynn County	61 437	23 947	17 308	13 214	3 346	6 638	5 647	2 319	1 840	2.57	3.04	1 089	683	406
Gordon County	34 740	12 778	9 938	8 236	1 320	2 838	2 530	1 116	817	2.72	3.13	323	322	1
Grady County	20 081	7 354	5 571	4 218	1 116	1 783	1 638	864	729	2.72	3.19	278	242	36
Greene County	11 663	4 082	3 012	2 098	791	1 071	974	503	385	2.86	3.42	130	107	23
Gwinnett County	351 247	129 071	98 396	82 398	10 401	30 675	22 501	3 637	3 036	2.77	3.16	1 688	1 580	106
Habersham County	25 817	9 906	7 672	6 525	946	2 294	2 108	973	787	2.59	3.05	1 806	1 495	311
Hall County	93 679	34 721	26 522	21 488	3 852	8 199	6 899	2 623	2 162	2.70	3.10	1 940	1 426	514
Hancock County	8 747	2 986	2 201	1 279	788	784	725	354	284	2.95	3.55	161	149	12
Haralson County	21 866	8 248	6 232	5 145	866	1 966	1 834	866	739	2.65	3.09	271	271	-
Harris County	17 624	6 464	5 082	4 169	714	1 382	1 234	558	421	2.73	3.12	164	164	-
Hart County	18 388	7 430	5 670	4 536	905	1 780	1 644	847	682	2.60	3.06	322	318	4
Heard County	8 406	3 003	2 308	1 912	364	695	613	280	208	2.75	3.17	130	125	5
Henry County	58 140	20 012	16 784	14 380	1 780	3 228	2 861	1 003	817	2.91	3.19	583	551	32
Houston County	87 884	32 430	24 695	19 712	3 987	7 735	6 677	1 708	1 420	2.71	3.15	1 284	665	620
Irwin County	8 520	3 142	2 380	1 763	480	782	752	402	319	2.71	3.22	129	129	-
Jackson County	29 286	10 721	8 383	6 886	1 080	2 388	2 086	986	781	2.73	3.13	710	546	164
Jasper County	8 388	3 038	2 307	1 758	426	728	644	332	232	2.76	3.21	64	64	-
Jeff Davis County	11 841	4 387	3 378	2 687	582	879	870	382	333	2.74	3.16	91	91	-
Jefferson County	16 889	6 080	4 480	2 985	1 354	1 604	1 487	779	608	2.78	3.38	400	400	-
Jenkins County	8 127	2 951	2 186	1 546	525	765	692	340	272	2.75	3.26	120	99	21
Johnson County	8 168	3 010	2 221	1 630	518	789	745	415	328	2.71	3.28	161	161	-
Jones County	20 519	7 330	5 881	4 606	938	1 489	1 343	470	363	2.81	3.21	220	188	32
Lamar County	12 738	4 686	3 588	2 706	703	1 101	1 001	487	385	2.73	3.18	279	120	159
Lanier County	5 400	1 886	1 535	1 144	297	460	418	186	148	2.79	3.22	71	63	8
Laurens County	36 630	14 514	10 622	8 002	2 294	3 892	3 374	1 569	1 271	2.48	3.16	1 158	1 102	56
Lee County	15 892	5 189	4 280	3 429	687	909	792	300	235	3.00	3.34	866	866	-
Liberty County	45 385	15 138	12 404	10 183	1 933	2 732	2 233	527	412	2.98	3.33	7 420	168	7 252
Lincoln County	7 387	2 702	2 089	1 567	382	643	593	305	231	2.74	3.21	45	28	17

NOTE: The population counts set forth herein are subject to possible correction for undercount or overcount. The United States Department of Commerce is considering whether to correct these counts and will publish corrected counts, if any, not later than July 15, 1991.

U.S. Department of Commerce, Proof Copy of table generated for 1990 CPH-1: Summary Population and Housing Characteristics, issued by Bureau of the Census (April 1991).

Table 6. Household, Family, and Group Quarters Characteristics: 1990 —Con.

For definitions of terms and meanings of symbols, see text

State / County / Place and (In Selected States) County Subdivision	Persons in households	All households	Family households: Total	Family households: Married-couple family	Family households: Female householder, no husband present	Nonfamily households: Total	Householder living alone: Total	65 years and over: Total	65 years and over: Female	Persons per—: Household	Persons per—: Family	Persons in group quarters: Total	Institutionalized persons	Other persons in group quarters
COUNTY—Con.														
Long County	6 119	2 198	1 583	1 303	218	513	447	185	134	2.78	3.22	83	4	79
Lowndes County	71 652	25 311	19 123	14 330	4 312	7 188	5 744	2 086	1 561	2.72	3.22	4 329	1 814	2 515
Lumpkin County	13 318	4 976	3 672	3 282	436	1 104	862	370	283	2.68	3.07	1 256	156	1 098
McDuffie County	19 482	7 270	5 508	3 985	1 298	1 762	1 558	676	539	2.73	3.19	257	232	25
McIntosh County	8 622	3 186	2 371	1 688	540	815	730	348	248	2.71	3.19	12	12	-
Macon County	12 626	4 388	3 322	2 398	1 046	1 066	991	513	412	2.82	3.46	288	288	-
Madison County	20 902	7 740	6 081	5 273	749	1 679	1 458	677	559	2.70	3.08	148	109	39
Marion County	5 512	1 962	1 524	1 132	317	438	392	203	166	2.81	3.22	78	78	-
Meriwether County	21 883	7 637	5 800	4 122	1 383	1 837	1 685	838	678	2.87	3.38	518	341	177
Miller County	6 184	2 338	1 741	1 334	319	595	554	318	250	2.65	3.14	98	98	-
Mitchell County	19 086	6 780	5 254	3 533	1 457	1 544	1 414	759	632	2.84	3.42	290	212	77
Monroe County	16 508	5 836	4 547	3 548	800	1 291	1 130	477	374	2.83	3.25	604	599	5
Montgomery County	6 714	2 403	1 842	1 432	323	651	590	313	235	2.80	3.20	449	213	236
Morgan County	12 705	4 398	3 442	2 580	581	957	854	417	329	2.89	3.32	178	158	20
Murray County	25 980	9 383	7 400	6 238	991	1 984	1 628	506	444	2.77	3.14	167	161	6
Muscogee County	171 700	65 858	47 235	33 380	11 903	18 623	16 122	5 647	4 716	2.61	3.12	7 578	2 963	4 615
Newton County	41 040	14 401	11 337	9 208	1 915	3 064	2 633	1 210	997	2.85	3.25	768	318	450
Oconee County	17 474	6 156	4 980	4 253	555	1 198	987	394	329	2.84	3.18	144	140	4
Oglethorpe County	9 481	3 581	2 748	2 188	448	833	737	317	240	2.70	3.14	82	82	-
Paulding County	41 289	14 328	11 998	10 350	1 218	2 327	1 984	772	594	2.88	3.17	322	309	13
Peach County	19 954	7 142	5 465	3 544	1 385	1 677	1 428	507	481	2.79	3.23	1 238	82	1 153
Pickens County	14 252	5 386	4 238	3 607	455	1 147	1 251	516	360	2.65	3.33	180	180	-
Pierce County	13 282	4 907	3 759	3 104	507	1 348	982	444	350	2.78	3.19	66	66	-
Pike County	10 100	3 528	2 824	2 285	317	722	647	321	255	2.88	3.28	124	124	-
Polk County	33 410	12 519	9 456	7 404	1 628	3 064	2 833	1 518	1 217	2.67	3.13	405	379	26
Pulaski County	7 388	3 098	2 185	1 586	504	913	842	432	348	2.58	3.15	122	122	-
Putnam County	13 856	5 229	3 938	3 043	702	1 291	1 118	429	330	2.65	3.07	281	277	4
Quitman County	2 205	857	626	428	167	231	214	112	72	2.57	3.08	4	-	4
Rabun County	11 480	4 630	3 477	2 940	412	1 153	1 008	524	404	2.48	2.88	188	166	22
Randolph County	7 804	2 815	2 003	1 301	595	812	773	463	365	2.73	3.38	329	104	225
Richmond County	178 514	68 675	47 695	32 988	12 384	20 980	17 907	5 732	4 570	2.61	3.18	10 205	3 423	6 782
Rockdale County	53 546	18 337	15 121	12 771	1 817	3 216	2 638	932	790	2.92	3.23	545	499	46
Schley County	3 581	1 315	964	739	178	351	324	171	153	2.72	3.25	7	7	-
Screven County	13 613	5 048	3 698	2 680	865	1 350	1 238	618	500	2.70	3.23	229	204	25
Seminole County	9 420	3 137	2 336	1 729	518	801	747	410	325	2.88	3.19	590	98	492
Spalding County	53 813	19 426	14 901	11 214	3 222	4 525	3 874	1 771	1 467	2.78	3.18	844	838	6
Stephens County	22 888	8 949	6 633	5 453	958	2 316	2 131	1 085	967	2.54	3.00	590	90	479
Stewart County	5 543	1 982	1 439	921	425	543	505	280	213	2.80	3.40	111	111	-
Sumter County	28 811	10 484	7 810	5 334	2 275	2 674	2 544	1 097	965	2.75	3.30	1 417	771	646
Talbot County	6 517	2 345	1 765	1 188	473	580	543	283	190	2.78	3.28	7	7	-
Taliaferro County	1 915	727	492	344	119	235	230	142	114	2.63	3.32	-	-	-
Tattnall County	15 251	5 845	4 272	3 278	826	1 573	1 436	733	580	2.61	3.11	2 471	2 189	282
Taylor County	7 632	2 804	2 070	1 431	530	734	675	387	302	2.72	3.24	10	10	-
Telfair County	10 641	4 017	2 901	2 380	688	1 116	1 044	590	470	2.65	3.20	359	344	15
Terrell County	10 508	3 738	2 772	1 823	804	966	887	448	393	2.81	3.34	148	148	-
Thomas County	38 325	14 323	10 644	7 604	2 564	3 679	3 342	1 624	1 333	2.68	3.16	661	580	81
Tift County	33 460	12 184	9 101	6 807	1 811	3 083	2 724	1 197	978	2.75	3.23	1 548	385	1 163
Toombs County	23 882	8 604	6 386	4 751	1 353	2 418	2 179	973	778	2.68	3.23	420	388	32
Towns County	6 382	2 812	2 058	1 815	183	754	712	387	285	2.28	2.69	392	78	314
Treutlen County	5 917	2 158	1 607	1 178	386	551	513	286	243	2.74	3.27	77	65	12
Troup County	54 500	20 371	14 980	11 050	3 282	5 391	4 771	2 231	1 827	2.68	3.18	1 096	711	385
Turner County	8 590	3 043	2 331	1 663	576	712	673	379	312	2.82	3.32	117	117	-
Twiggs County	9 689	3 298	2 570	1 898	553	728	666	281	222	2.87	3.29	190	182	8
Union County	11 700	4 709	3 663	3 182	355	1 086	980	535	406	2.50	2.88	324	321	3
Upson County	25 840	9 811	7 335	5 487	1 541	2 578	2 377	1 282	1 046	2.61	3.09	480	468	12
Walker County	57 524	21 607	16 687	13 686	2 325	4 810	4 305	2 111	1 758	2.66	3.05	816	806	10
Walton County	38 229	13 433	10 749	8 636	1 813	2 684	2 332	1 101	863	2.85	3.22	357	357	-
Ware County	33 798	13 048	9 418	7 080	1 945	3 630	3 311	1 624	1 317	2.59	3.12	1 603	1 583	20
Warren County	5 874	2 130	1 603	1 056	467	527	487	296	241	2.80	3.30	104	104	-
Washington County	18 788	6 738	4 986	3 386	1 330	1 754	1 608	776	624	2.79	3.32	323	311	12
Wayne County	21 781	7 622	6 113	4 803	1 053	1 809	1 670	783	606	2.75	3.19	595	582	13
Webster County	2 263	798	610	446	131	188	172	86	61	2.84	3.32	-	-	-
Wheeler County	4 817	1 786	1 331	1 039	235	455	441	273	223	2.70	3.21	89	68	21
White County	12 523	4 907	3 799	3 288	382	1 108	1 023	475	374	2.55	2.95	483	161	322
Whitfield County	71 808	25 869	20 506	16 611	2 940	6 353	5 456	1 905	1 633	2.67	3.08	654	571	83
Wilcox County	6 807	2 511	1 833	1 389	380	678	640	378	293	2.71	3.27	201	201	-
Wilkes County	10 511	4 032	2 932	2 132	646	1 090	1 008	566	415	2.61	3.12	88	88	-
Wilkinson County	10 183	3 619	2 755	2 032	616	864	790	352	274	2.81	3.31	45	45	-
Worth County	19 618	6 895	5 428	4 107	1 057	1 467	1 346	675	541	2.85	3.27	127	53	74
PLACE AND COUNTY SUBDIVISION														
Abbeville city	869	303	221	153	54	82	76	49	40	2.87	3.16	98	98	-
Dodge County	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Wilcox County	869	303	221	153	54	82	76	49	40	2.87	3.16	98	98	-
Acworth city, Cobb County	4 517	1 758	1 280	1 017	198	498	402	153	137	2.57	3.04	2	2	-
Adairsville city, Bartow County	2 131	772	587	391	160	185	168	95	71	2.76	3.19	-	-	-
Adel city, Cook County	4 927	1 793	1 289	859	358	504	466	246	207	2.75	3.33	166	128	38
Adrian city	615	238	170	116	45	68	62	33	30	2.58	3.08	-	-	-
Emanuel County	293	113	86	64	18	27	26	15	14	2.59	2.98	-	-	-
Johnson County	322	125	84	52	27	41	36	18	16	2.58	3.18	-	-	-
Ailey city, Montgomery County	484	183	138	100	24	48	45	26	22	2.64	3.15	96	-	96
Alamo city, Wheeler County	840	318	232	182	56	87	85	58	40	2.65	3.24	6	6	-
Alapaha town, Berrien County	788	287	222	148	64	65	63	27	23	2.75	3.20	23	-	23
Albany city, Dougherty County	75 233	27 808	19 877	12 351	6 726	7 949	6 900	2 482	1 982	2.68	3.25	2 889	1 120	1 769
Aldora town, Lamar County	127	46	35	30	4	11	11	8	5	2.76	3.29	-	-	-
Allenhurst town, Liberty County	594	210	163	138	20	47	38	11	10	2.83	3.20	-	-	-
Allentown town	273	105	80	65	14	25	23	13	11	2.60	3.05	-	-	-
Bleckley County	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Laurens County	2	1	1	1	-	-	-	-	-	2.00	2.00	-	-	-
Twiggs County	40	14	11	9	2	3	3	1	1	2.86	3.36	-	-	-
Wilkinson County	231	90	68	55	12	22	20	12	10	2.57	3.01	-	-	-
Alma city, Bacon County	3 533	1 397	959	571	355	438	417	234	191	2.53	3.11	130	121	9
Alpharetta city, Fulton County	12 684	5 205	3 603	3 013	478	1 602	1 282	290	240	2.45	2.95	118	118	-
Alston town, Montgomery County	112	39	42	38	4	14	13	11	8	2.88	3.45	-	-	-

TPS8 (POSTSCRIPT) CPH112 CENSUS90 TS/REDO 08/08/91 8:18 AM MACHINE: C DATA:CENSUS90 PH1TPEDAT13, 08/08/91 08:08:14 OUTPUT:CHGITS-P2386 PAGE: 91
TSF:CENSUS90'93, 08/08/91 08:08:20 UTF:CENSUS90'93, 08/08/91 08:08:20 META:CENSUS90'PH1TABLES13, 08/08/91 08:14:57

NOTE: The population counts set forth herein are subject to possible correction for undercount or overcount. The United States Department of Commerce is considering whether to correct these counts and will publish corrected counts, if any, not later than July 15, 1991.

REFERENCE 18

ENDANGERED AND THREATENED SPECIES

U.S. FISH AND WILDLIFE SERVICE

REGION 4 - ATLANTA

PREFACE

The materials in this notebook are provided as an aid to anyone having a continuing need for current information on Federally listed endangered and threatened species found within Region 4 of the U.S. Fish and Wildlife Service. This area includes the Carolinas, Georgia, Florida, Alabama, Tennessee, Kentucky, Mississippi, Arkansas, Louisiana, Puerto Rico, and the Virgin Islands.

Recipients of the notebook are placed on a permanent mailing list and will automatically receive updated information whenever listing or other changes occur. Questions or comments pertaining to the notebook should be directed to the Endangered Species Office, U.S. Fish and Wildlife Service, Richard B. Russell Federal Building, 75 Spring St., S.W., Atlanta, Georgia 30303; telephone 404/221-3583 or FTS 242-3583. Other questions pertaining to endangered species matters should be addressed to one of the Service field stations listed at the end of this Preface.

The notebook is divided into two primary sections. Materials in the first section provide quick reference as to what species are listed, proposed, or under review, the states where they occur, the location of critical habitat areas, and other related information. The second part of the notebook contains species accounts which briefly discuss such things as the status, range, life history, and management needs of listed species. Please note that the range maps for these species generally reflect current distribution, but in many cases they reflect distribution rather broadly and should only be interpreted in relation to other information included in the species account.

The Endangered Species Act - General

Passage of the Endangered Species Act of 1973 gave the United States one of the most far-reaching laws ever enacted by any country to prevent the extinction of imperiled animals and plants. Under the law, the Secretary of the Interior (acting through the U.S. Fish and Wildlife Service) has broad powers to protect and conserve all forms of wildlife and plants he finds in serious jeopardy. The Secretary of Commerce, acting through the National Marine Fisheries Service, has similar authority for protecting and conserving most marine life.

Congress addressed the question of why we should save endangered species in the preamble to the Endangered Species Act, holding that endangered and threatened species of fish, wildlife and plants "are of esthetic, ecological, educational, historical, recreational, and scientific value to the Nation and its people." In making this statement, Congress was summarizing a number of convincing arguments advanced by thoughtful scientists, conservationists, and others who are greatly concerned by the disappearance of wildlife.

Protecting endangered species and restoring them to the point where their existence is no longer jeopardized is the primary objective of the U.S. Fish and Wildlife Service's Endangered Species Program.

It should be emphasized, however, that not all Federal actions will necessarily be detrimental to critical habitat. There may be many kinds of actions which can be carried out within a critical habitat area without reducing the species' numbers or distribution, or otherwise posing jeopardy to it.

In summary, the designation of critical habitat does not create a nature preserve or refuge. It does not affect private, local, or state projects unless Federal funds or permits are involved. It does provide a means by which listed species can be protected from adverse impacts resulting from Federal action.

Consultation

Section 7 of the Act requires all Federal agencies to review their actions, and if they determine that their actions may affect a listed species or its habitat, they must enter into consultation with the Fish and Wildlife Service. During the course of such consultation the involved agency and the Fish and Wildlife Service will try to determine a course of action which will allow for completion of the agency's project and at the same time not jeopardize the species. Most consultations accomplish this goal.

In the case of a conflict, the Act provides a means whereby under certain conditions the affected Federal agency may be exempted from the requirements of Section 7. Exemption applications must be submitted to the Secretary of the Interior for consideration. If the Secretary decides the application meets exemption criteria, it is then passed on to a seven-member cabinet-level Endangered Species Committee for a final decision.

Conservation and Recovery

A main aim of the Service's Endangered Species Program is to restore populations of listed species to a point where they are no longer in danger of extinction and are again self-sustaining members of their ecosystem. Recovery plans for a number of these species are already being carried out. The plans may recommend the acquisition of land, new research, captive breeding, or may call for special wildlife and habitat management techniques.

In addition to overseeing the development and implementation of recovery plans, the Fish and Wildlife Service utilizes the authorities and funding provided under the Act to provide for technical assistance, management, law enforcement, land acquisition, research, status surveys, and financial assistance to state agencies which have entered into a cooperative agreement with the Service.

Permits

The Service's Wildlife Permit Office can issue permits for certain activities involving endangered or threatened species. Permits for

12/16/87

Endangered and Threatened Species in Region 4*

(E=Endangered; T=Threatened)

Mammals:	Distribution:
Bat, gray (E)	AL,AR,FL,GA,KY,NC,TN
Bat, Indiana (E)	AL,AR,FL,GA,KY,NC,TN
Bat, Ozark big-eared (E)	AR
Bat, Virginia big-eared (E)	KY,NC
Cougar, Eastern (E)	KY,NC,SC,TN
Deer, Key (E)	FL
Manatee, West Indian (E)	AL,FL,GA,NC,PR,SC
Mouse, Alabama beach (E)	AL
Mouse, Choctawhatchee beach (E)	FL
Mouse, Key Largo cotton (E)	FL
Mouse, Perdido Key beach (E)	AL, FL
Panther, Florida (E)	AL,AR,FL,GA,LA,MS,SC,TN
Shrew, Dismal Swamp southeastern (T)	NC
Squirrel, Carolina northern flying (E)	NC,TN
Whale, finback (E)	Oceanic
Whale, humpback (E)	Oceanic
Whale, right (E)	Oceanic
Whale, sei (E)	Oceanic
Whale, sperm (E)	Oceanic
Wolf, red (E)	LA
Woodrat, Key Largo (E)	FL

Birds:	
Blackbird, yellow-shouldered (E)	PR
Caracara, Audubon's Crested (T)	FL
Crane, Mississippi Sandhill (E)	MS
Curlew, Eskimo (E)	LA (historic, near extinction)
Eagle, bald Southeastern (E)	AL,AR,FL,GA,KY,LA,MS,NC,SC,TN
Falcon, American peregrine Eastern (E)	AL,GA,KY,NC,SC,TN
Falcon, Arctic peregrine (T)	AL,AR,FL,GA,KY,LA,MS,NC,PR, SC,TN
Jay, Florida scrub (T)	FL
Kite, Everglade (E)	FL
Parrot, Puerto Rican (E)	PR
Pelican, brown (E)	LA,MS,PR,VI

*Includes the Carolinas, Georgia, Florida, Alabama, Tennessee, Kentucky, Mississippi, Arkansas, Louisiana, Puerto Rico, and the Virgin Islands.

Reptiles and Amphibians (cont'd):	Distribution
Turtle, Alabama red-bellied (E)	AL
Turtle, flattened musk (T)	AL
Turtle, green (T) (E in Florida)	AL,FL,GA,LA,MS,NC,PR,SC,VI
Turtle, hawksbill (E)	AL,FL,GA,LA,MS,NC,PR,SC,VI
Turtle, Kemp's (Atlantic) ridley (E)	AL,FL,GA,LA,MS,NC,SC
Turtle, leatherback (E)	AL,FL,GA,LA,MS,NC,PR,SC,VI
Turtle, loggerhead (T)	AL,FL,GA,LA,MS,NC,PR,SC,VI
Turtle, ringed sawback (T)	LA,MS
Fishes:	
Cavefish, Alabama (T)	AL
Cavefish, Ozark (T)	AR
Chub, slender (T)	TN
Chub, spotfin (T)	NC,TN
Dace, blackside (T)	KY,TN
Darter, amber (E)	TN,GA
Darter, Bayou (T)	MS
Darter, leopard (T)	AR
Darter, Okaloosa (E)	FL
Darter, slackwater (T)	AL,TN
Darter, snail (T)	GA,TN,AL
Darter, watercress (E)	AL
Logperch, Conasauga (E)	TN,GA
Madtom, smoky (E)	TN
Madtom, yellowfin (T)	TN
Shiner, Cape Fear (E)	NC
Silverside, Waccamaw (T)	NC
Sturgeon, shortnose (E)	FL,GA,NC,SC
Mollusks:	
Mussel, Alabama lamp pearly (E)	AL,TN
Mussel, Appalachian monkeyface (E)	TN
Mussel, birdwing pearly (E)	TN
Mussel, Cumberland bean pearly (E)	KY,TN
Mussel, Cumberland monkeyface pearly (E)	TN
Mussel, Curtus' (E)	MS
Mussel, dromedary pearly (E)	TN
Mussel, fat pocketbook pearly (E)	AR
Mussel, fine-rayed pigtoe pearly (E)	AL,TN
Mussel, green-blossom pearly (E)	TN
Mussel, Judge Tait's (E)	AL,MS
Mussel, Marshall's (E)	AL

Plants (cont'd):	Distribution
Four-petal pawpaw (E)	FL
Fragrant prickly-apple (E)	FL
Garber's spurge (T)	FL
Geocarpon minimum (T)	AR
Green pitcher plant (E)	AL,GA,NC
Hairy rattleweed (E)	GA
Harper's beauty (E)	FL
Heller's blazing star (T)	NC
Highlands scrub hypericum (E)	FL
Higuero de Sierra (E)	PR
Key tree-cactus (E)	FL
Lakela's mint (E)	FL
Large-flowered skullcap (E)	GA,TN
Longspurred mint (E)	FL
Miccosukee gooseberry (T)	FL,SC
Mountain golden heather (T)	NC
Palo de Ramon (E)	PR
Papery whitlow-wort (T)	FL
Persistent trillium (E)	GA,SC
Pondberry (E)	AR,GA,MS,NC,SC
Prickly-ash (E)	PR, VI
Pygmy fringe tree (E)	FL
Rough-leaved loosestrife (E)	NC
Rugel's pawpaw (E)	FL
Ruth's golden aster (E)	TN
Scrub lupine (E)	FL
Scrub mint (E)	FL
Scrub plum (E)	FL
Short's goldenrod (E)	KY
Small whorled pogonia (E)	GA,NC,SC,TN
Small's milkpea (E)	FL
Snakeroot (E)	FL
Tennessee coneflower (E)	TN
Tiny polygala (E)	FL
Vahl's boxwood (E)	PR
Wheeler's peperomia (E)	PR
Wide-leaf warea (E)	FL
Wireweed (E)	FL

CRITICAL HABITAT INDEX

Alabama - *Etheostoma boschungi*, "slackwater darter"
Peromyscus polionotus ammobates, "Alabama beach mouse"
Peromyscus polionotus trissyllepsis, "Perdido Key beach mouse"
Speoplatyrhinus poulsoni, "Alabama cavefish"

Arkansas - *Percina pantherina*, "leopard darter"

Florida - *Ammospiza maritima mirabilis*, "Cape Sable sparrow"
Ammospiza maritima nigrescens, "dusky seaside sparrow"
Crocodylus acutus, "American crocodile"
Peromyscus polionotus allophrys, "Choctawhatchee beach mouse"
Peromyscus polionotus trissyllepsis, "Perdido Key beach mouse"
Rostrhamus sociabilis plumbeus, "Everglade kite"
Trichechus manatus, "Florida manatee"

Georgia - *Percina antesella*, "amber darter"
Percina jenkinsi, "Conasauga logperch"

Kentucky - *Myotis sodalis*, "Indiana bat"
Palaemonias ganteri, "Kentucky cave shrimp"

Louisiana - No designations

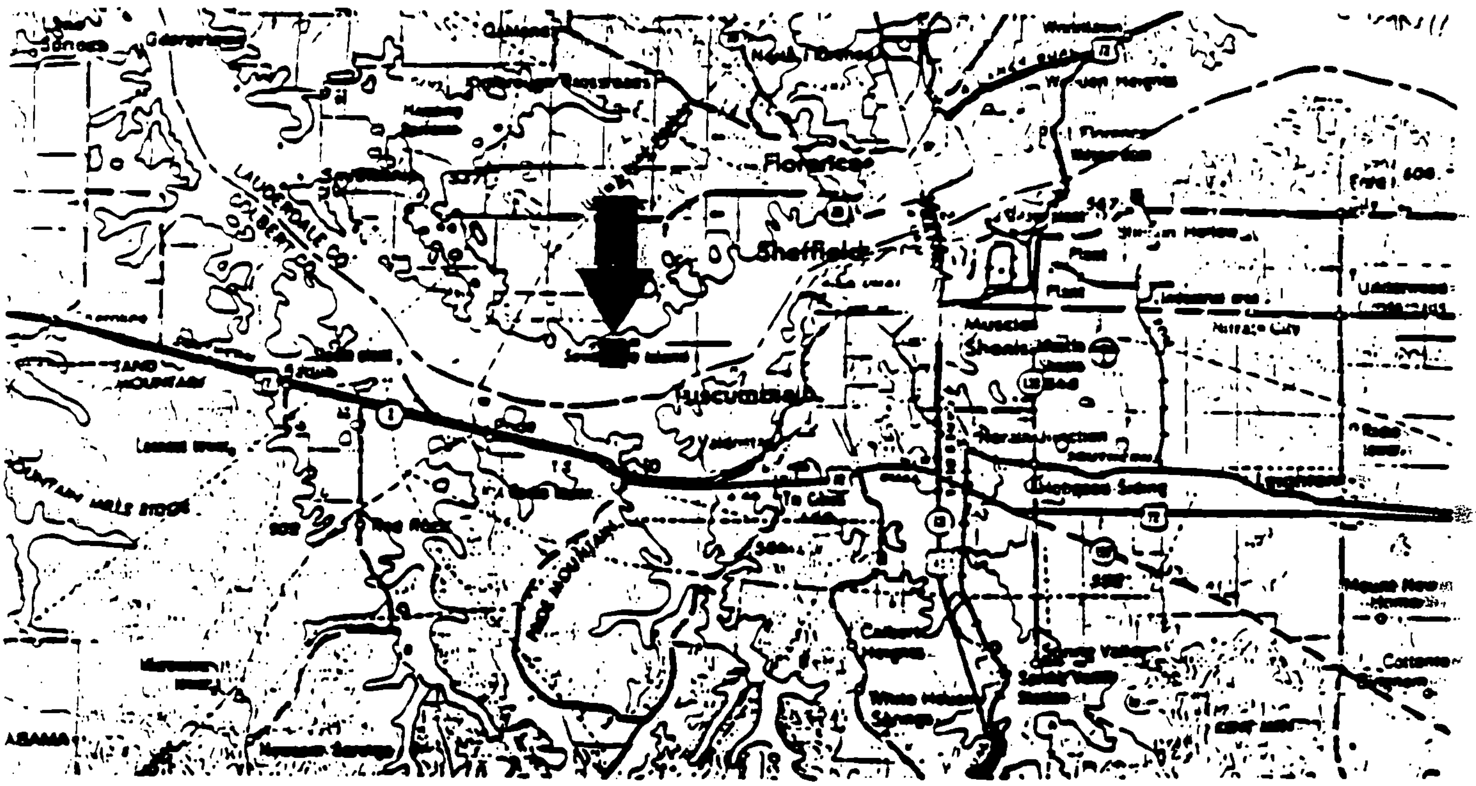
Mississippi - *Grus canadensis pulla*, "Mississippi sandhill crane"

North Carolina - *Hudsonia montana*, "mountain golden heather"
Hybopsis monacha, "spotfin chub"
Menidia extensa, "Waccamaw silverside"
Notropis mekistocholas, "Cape Fear shiner"

ALABAMA - Critical Habitat

Speoplatyrhinus poulsoni, "Alabama cavefish"

Critical Habitat for the Alabama cavefish is Key Cave in Lauderdale County.

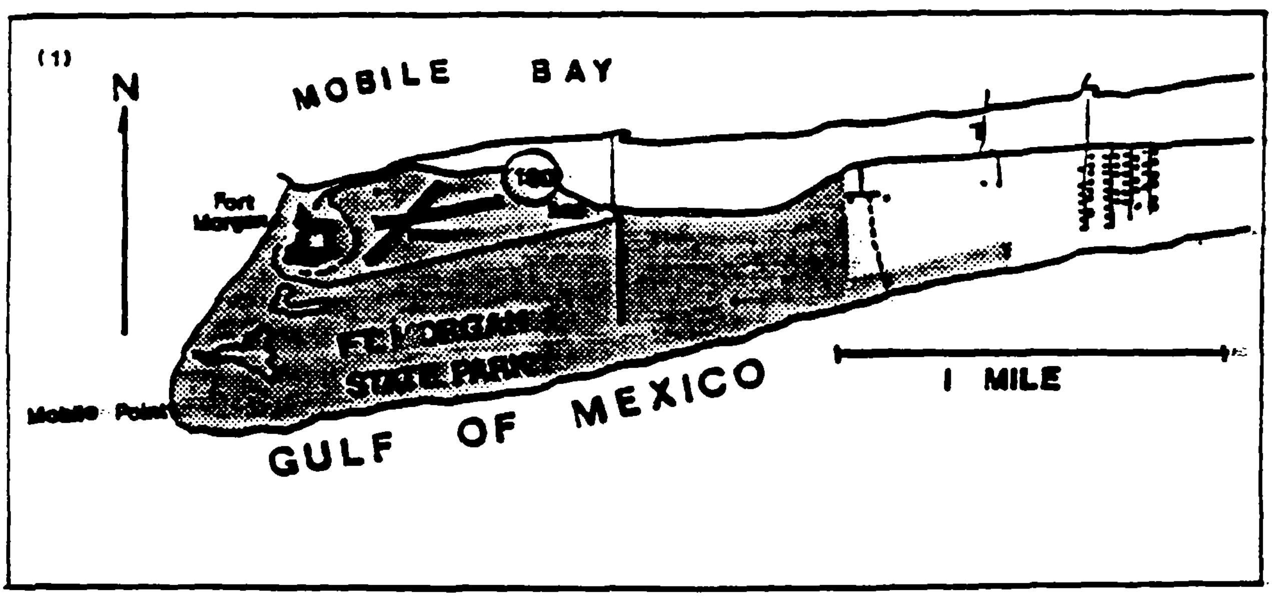


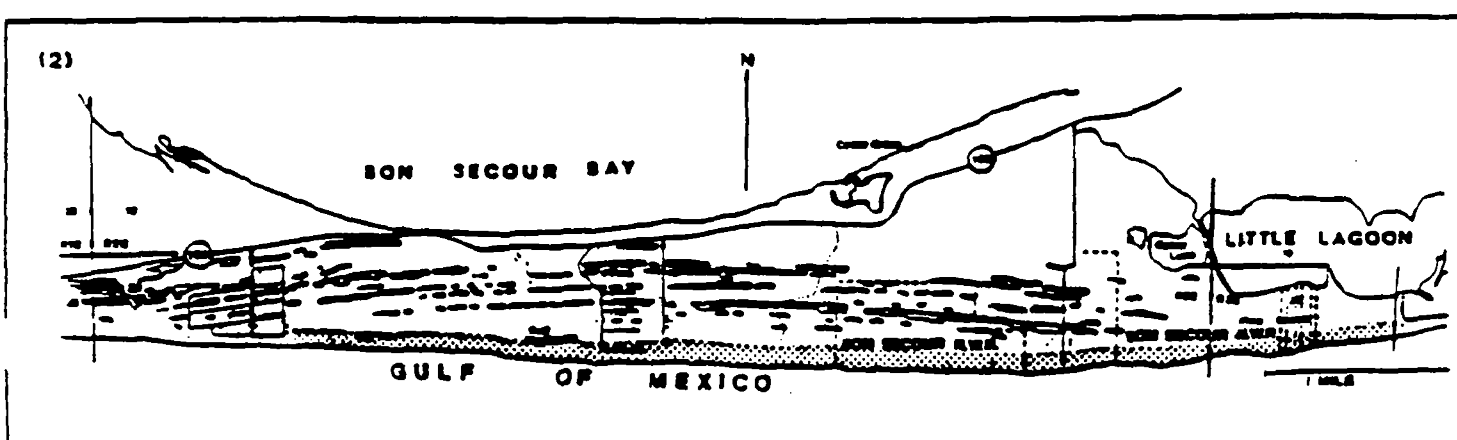
ALABAMA - Critical Habitat

Peromyscus polionotus ammobates, "Alabama beach mouse"

Areas of land, water and airspace in Baldwin County with the following components (St. Stephens Meridian): (1) that portion of the Fort Morgan Peninsula south of State Road 180 and west of 87° 59' 35" W, except for that part each of Fort Morgan State Park and more than 152.5 meters (500 feet) inland from the mean high tide line of the Gulf of Mexico; (2) those portions of T9S R3E Sec. 30 and T9S R2E Sec. 25-28 and E 15/16 Sec. 29 extending 152.5 meters (500 feet) inland from the mean high tide line of the Gulf of Mexico; (3) that portion of the Gulf Shores unit of the Gulf State Park south of State Road 182 in T9S R4E Sec. 14-15 and Sec. 21-23.

Within these areas the major constituent elements that are known to require special management considerations or protection are dunes and interdunal areas, and associated grasses and shrubs that provide food and cover.

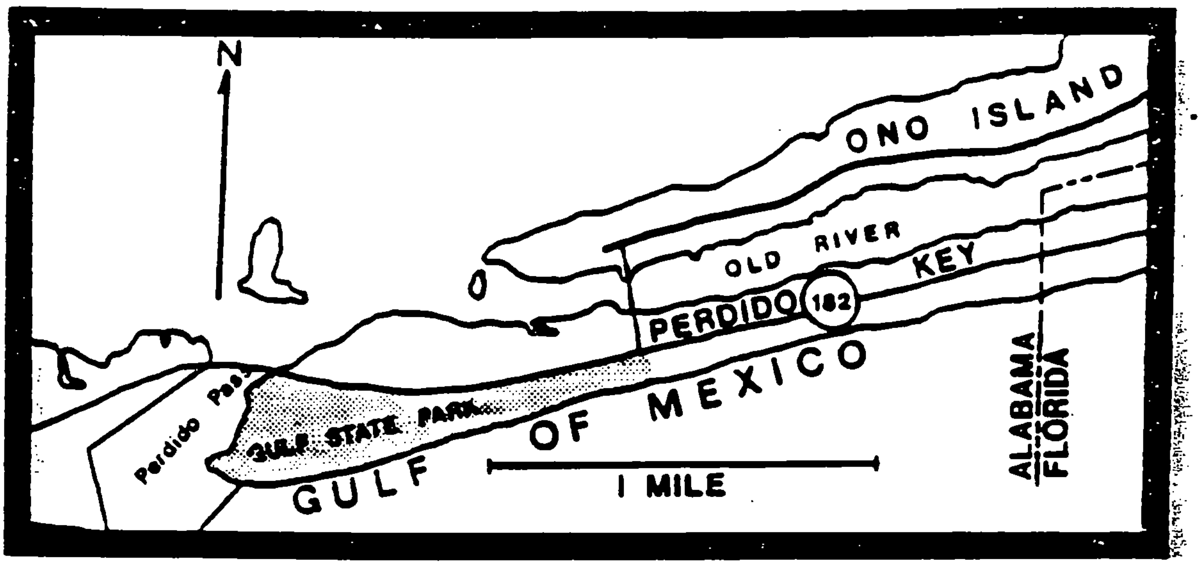




Peromyscus polionotus trissyllepsis, "Perdido Key beach mouse"

An area of land, water, and airspace in Baldwin County with the following component (Tallahassee Meridian): that portion of the Perdido Key unit of the Gulf State Park south of State Road 182 in T9S R33W Sec. 2-3.

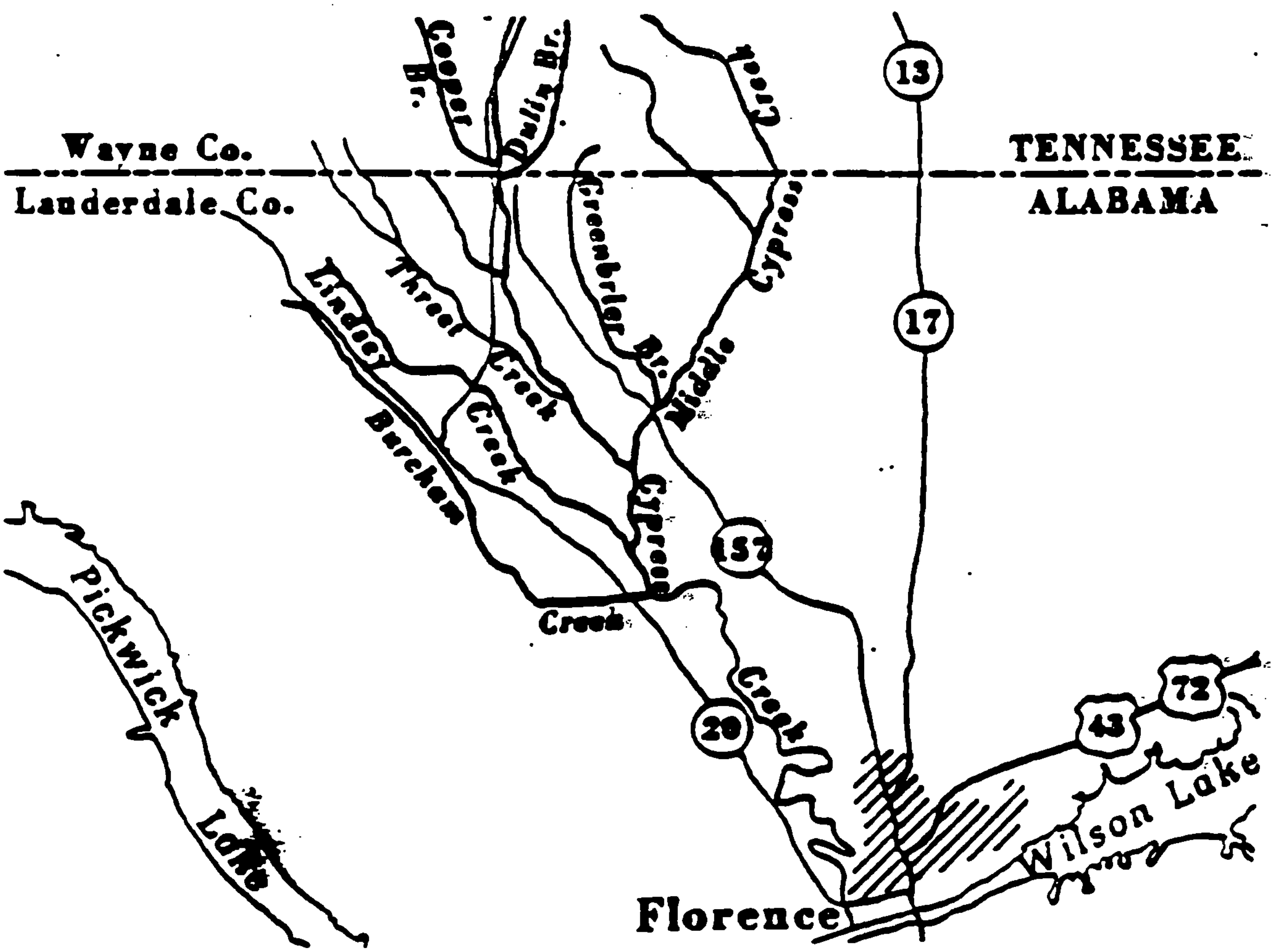
Within this area the major constituent elements that are known to require special management considerations or protection are dunes and interdunal areas, and associated grasses and shrubs that provide food and cover.



ALABAMA - Critical Habitat

Etheostoma boschungi, "slackwater darter"

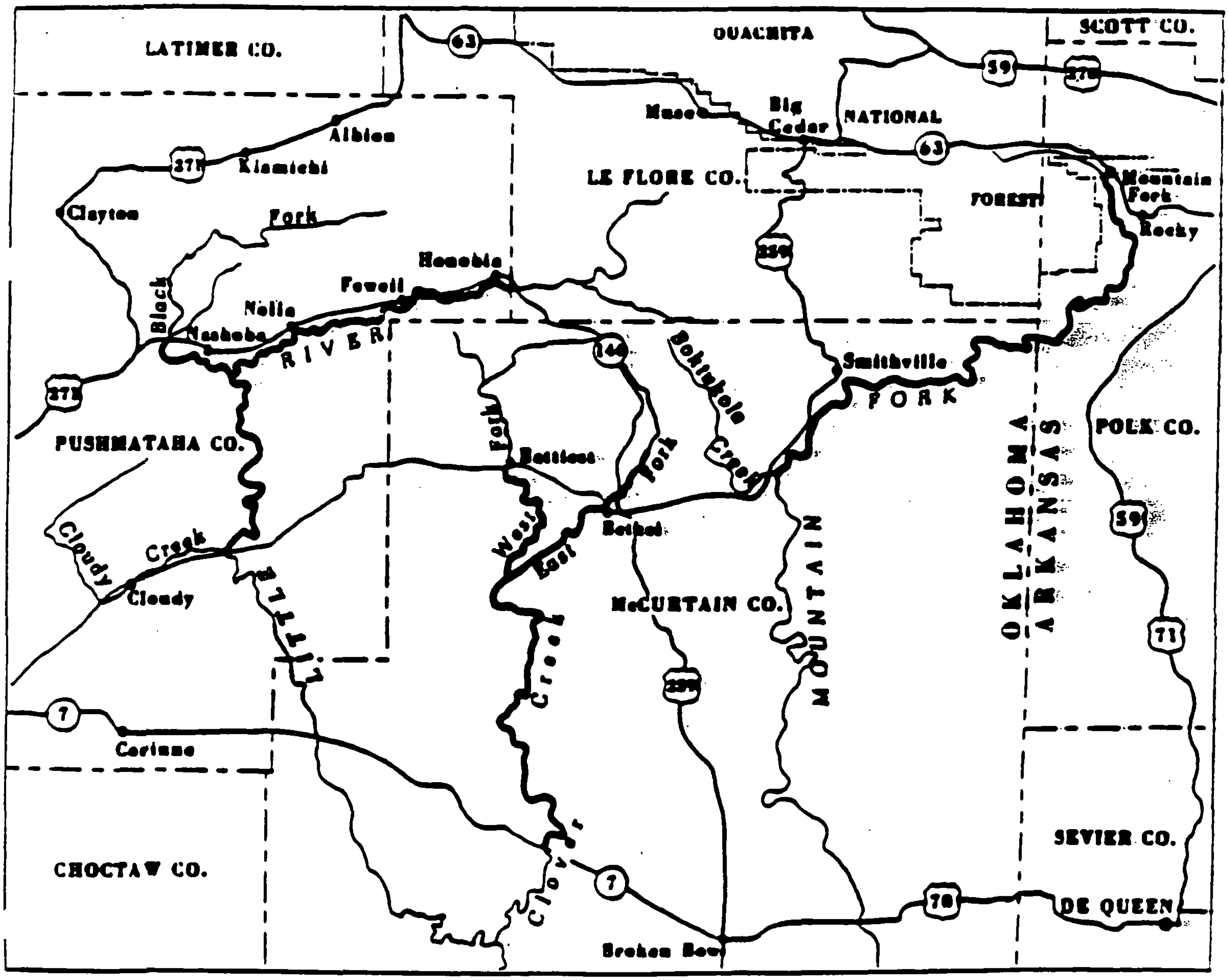
Lauderdale County. All permanent and intermittent streams with flowing water from December to June tributary to Cypress Creek and its tributaries upstream from the junction of Burcham Creek, including Burcham Creek, excluding Threet Creek and its tributaries.



ARKANSAS - Critical Habitat

Percina pantherina, "leopard darter"

Polk County. Mountain Fork Creek, main channel from the Arkansas-Oklahoma state line upstream to the community of Mountain Fork (T.1S.; R. 32W.; Section 29).



FLORIDA - Critical Habitat

Rostrhamus sociabilis plumbeus, "everglade kite"

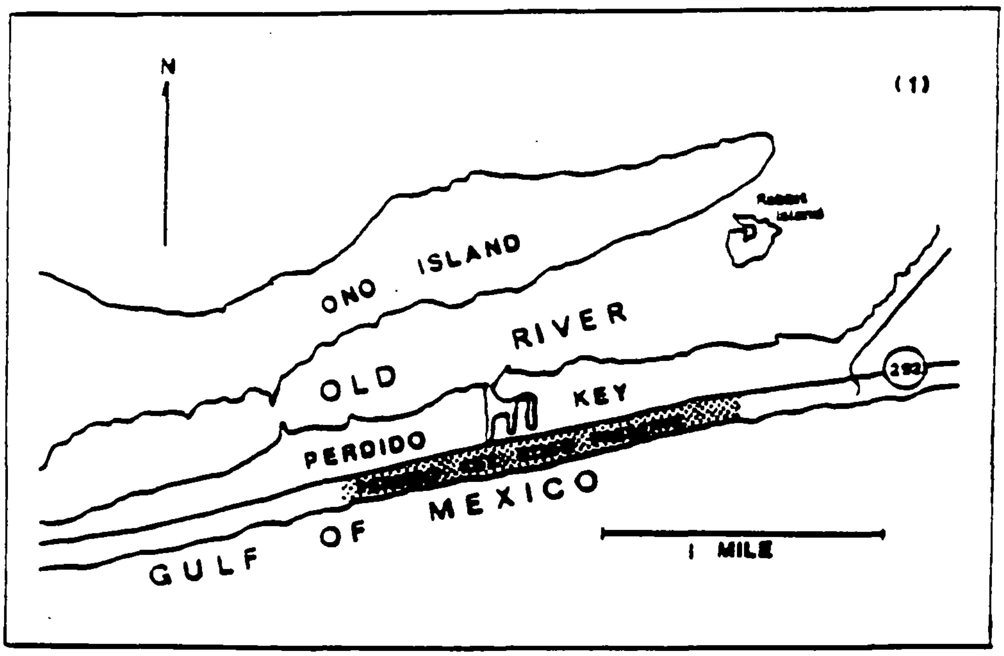
Florida. Areas of land (predominantly marsh), water, and airspace, with the following components (Tallahassee Meridian): (1) St. Johns Reservoir, Indian River County: T33S R37E SW¼ Sec. 6, W½ Sec. 7, Sec. 18, Sec. 19; (2) Cloud Lake Reservoir, St. Lucie County: T34S R38E S½ Sec. 16, N½ Sec. 21; (3) Strazzulla Reservoir, St. Lucie County: T34S R38E SW ¼ Sec. 21; (4) western parts of Lake Okeechobee, Glades and Hendry Counties, extending along the western shore to the east of the levee system and the undiked high ground at Fisheating Creek, and from the Hurricane Gate at Clewiston northward to the mouth of the Kissimmee River, including all the Eleocharis flats of Moonshine Bay, Monkey Box, and Observation Shoal, but excluding the open water north and west of the northern tip of Observation Shoal, north of Monkey Box, and east of Fisheating Bay; (5) Loxahatchee National Wildlife Refuge (Central and Southern Florida Flood Control District Water Conservation Area 1), Palm Beach County, including Refuge Management Compartments A, B, C, and D, and all of the main portion of the Refuge as bounded by Levees L-7, L-39, and L-40; (6) Central and Southern Florida Flood Control District Water Conservation Area 2A, Palm Beach and Broward Counties, as bounded by Levees L-6, L-35B, L-36, L-38, and L-39; (7) Central and Southern Florida Flood Control District Water Conservation Area 2B, Broward County, as bounded by Levees L-35, L-35B, L-36, and L-38; (8) Central and Southern Florida Flood Control District Water Conservation Area 3A, Broward and Dade Counties, as bounded by Florida Highway 84, Levees L-68A, L-67A (north of Miami Canal), L-67C (south of Miami Canal), L-29, and L-28, and a line along the undiked northwestern portion of the Area; (9) that portion of Everglades National Park, Dade County, within the following boundary: beginning at the point where the Park boundary meets Florida Highway 94 in T54S R35E Sec. 20, thence eastward and southwest along the Park boundary to the southwest corner of Sec. 31 in T57S R37E, thence southwestward along a straight line to the southwest corner of Sec. 2 in T58S R35E, thence westward along the south sides of Sec. 3, 4, 5, and 6 in T58S R35E to the Dade-Monroe county line, thence northward along the Dade-Monroe county line to the Park boundary, thence eastward and northward along the Park boundary to the point of beginning.

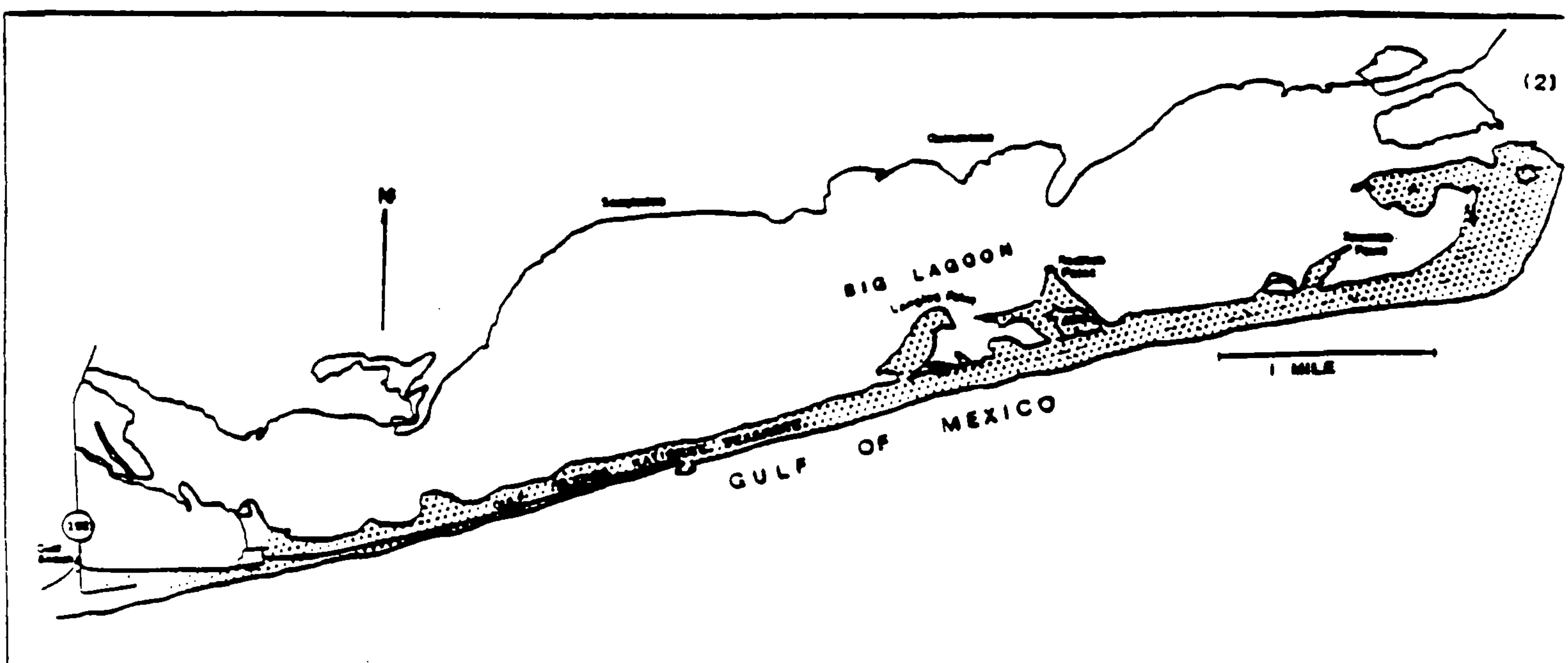
(over)

<u>Peromyscus</u> <u>polionotus</u> <u>trissyllepsis</u>, "Perdido Key beach mouse"

Areas of land, water, and airspace in Escambia County with the following components (Tallahassee Meridian): (1) that portion of the Perdido Key State Preserve south of State Road 292 in T3S R32W Sec. 32-33 and T4S R32W Sec. 5; (2) those portions of Perdido Key in T3S R31W Sec. 25-26 and Sec. 28-34, and in T3S R32W E 1/2 Sec. 36, and W 1/2 Sec. 36 south of the entrance road, parking lot, and Johnson Beach recreational facilities at the Gulf Islands National Seashore.

Within these areas the major constituent elements that are known to require special management considerations or protection are dunes and interdunal areas, and associated grasses and shrubs that provide food and cover.

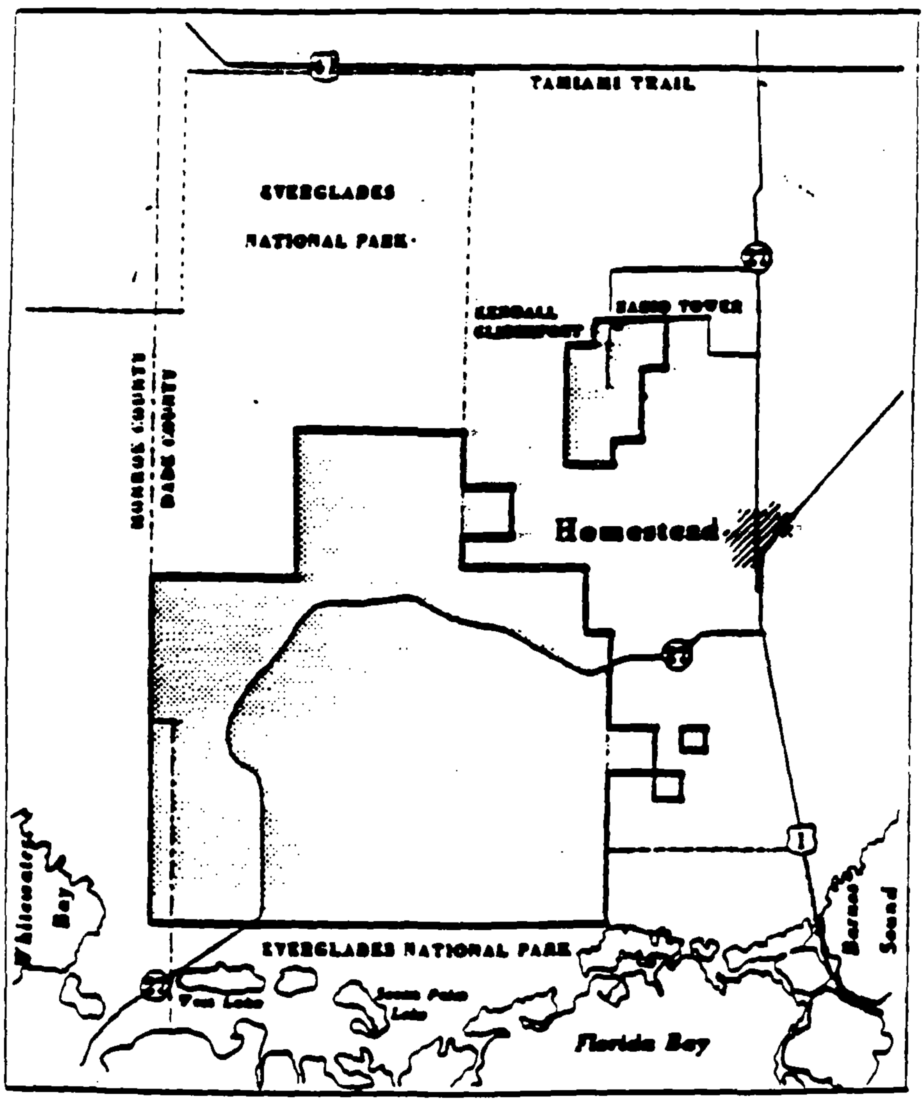




FLORIDA - Critical Habitat

Ammospiza maritima mirabilis, "Cape Sable sparrow"

Florida. Areas of land, water, and airspace in the Taylor Slough vicinity of Collier, Dade, and Monroe counties, with the following components (Tallahassee Meridian): Those portions of Everglades National Park within T57S R36E, T57S R36½E, T57S R37E, T58S R35E, T58S R36E, T58S R37E, T58½S R35E, T58½S R36½E, T59S R35E, T59S R36E, T59S R37E. Areas outside of Everglades National Park within T55S R37E Sec. 36; T55S R38E Sec. 31, 32; T56S R37E Sec. 1, 2, 11-14, 23-26; T56S R38E Sec. 5-7, 18, 19; T57S R37E Sec. 5-8, T58S R38E Sec. 27, 29-32; T59S R38E Sec. 4.



FLORIDA - Critical Habitat

Ammospiza maritima nigrescens, "dusky seaside sparrow"

Florida. Cordgrass (Spartina bakerii) savannas and associated land, water, and airspace within the following boundary, Brevard County: Beginning at the point where Florida Highway 528 intersects Interstate Highway 95; thence westward along Florida Highways 528 and 520 to the main channel of the St. Johns River; thence northward along said channel to Florida Highway 46; thence eastward along Florida Highway 46 to Interstate Highway 95; thence southward along Interstate Highway 95 to the point of beginning. Marshes and associated airspace within the mosquito control impoundments designated by the Brevard County Mosquito Control District as T-10-J and T-10-K, northwest of Florida Highway 406 on the Merritt Island National Wildlife Refuge, Brevard County.

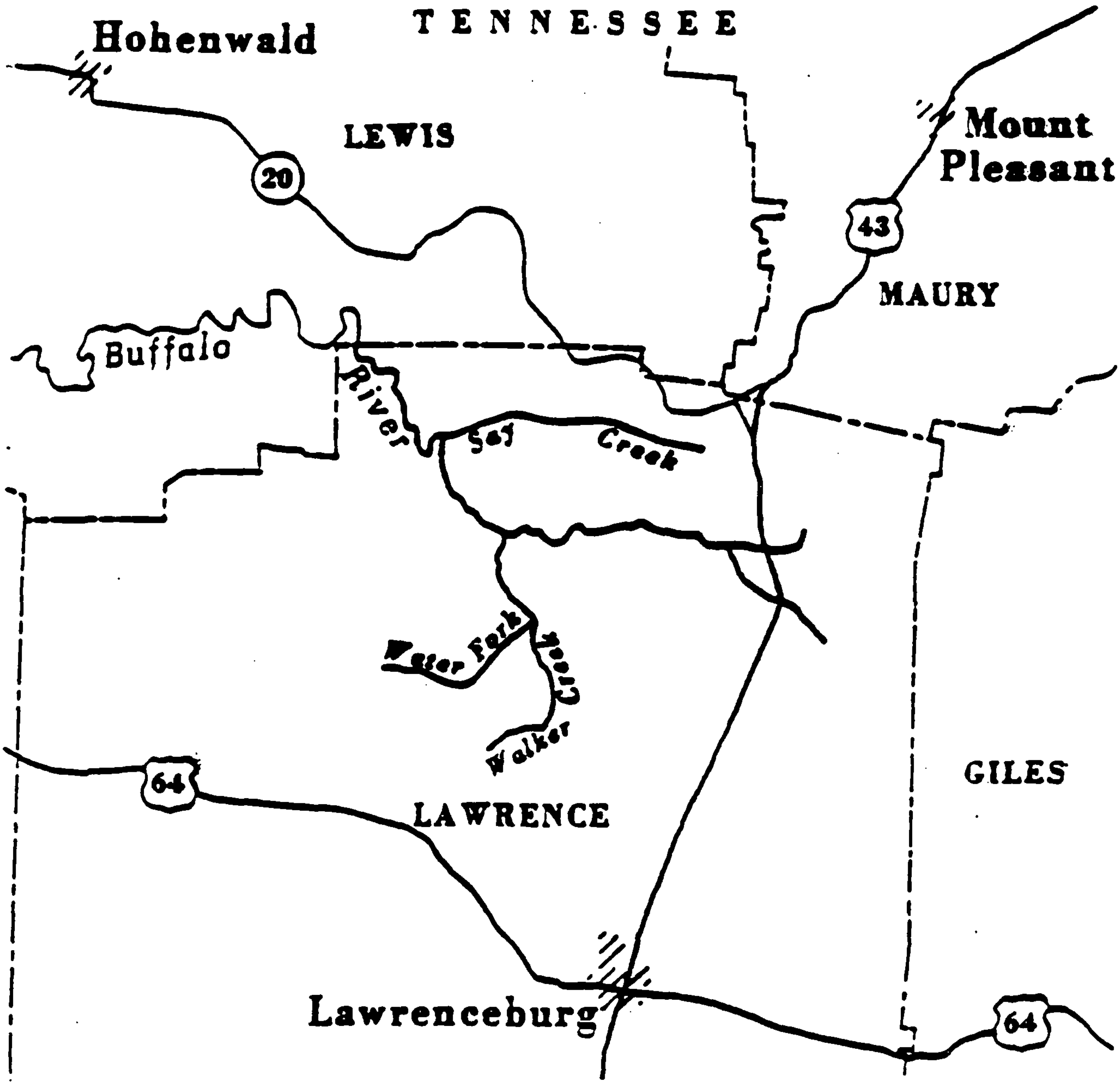
(over)

TENNESSEE - Critical Habitat

Etheostoma boschungi, "slackwater darter"

Wayne County. All permanent and intermittent streams with flowing water from December to June tributary to Cypress and Middle Cypress Creek drainage.

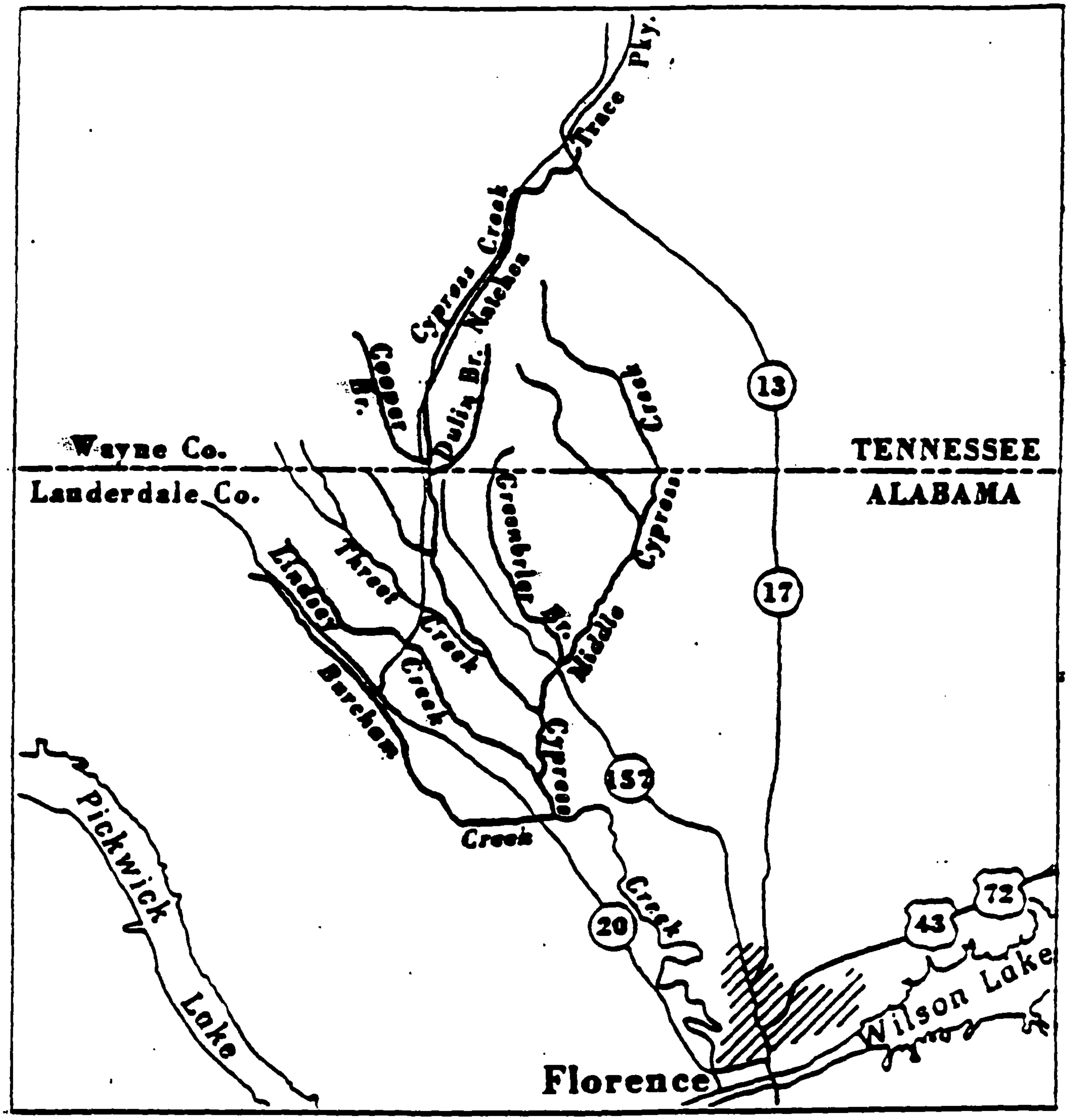
Lawrence County, Buffalo River and its tributaries in Lawrence County, Tennessee.



SLACKWATER DARTER

Lauderdale Co., ALABAMA and Wayne Co., TENNESSEE

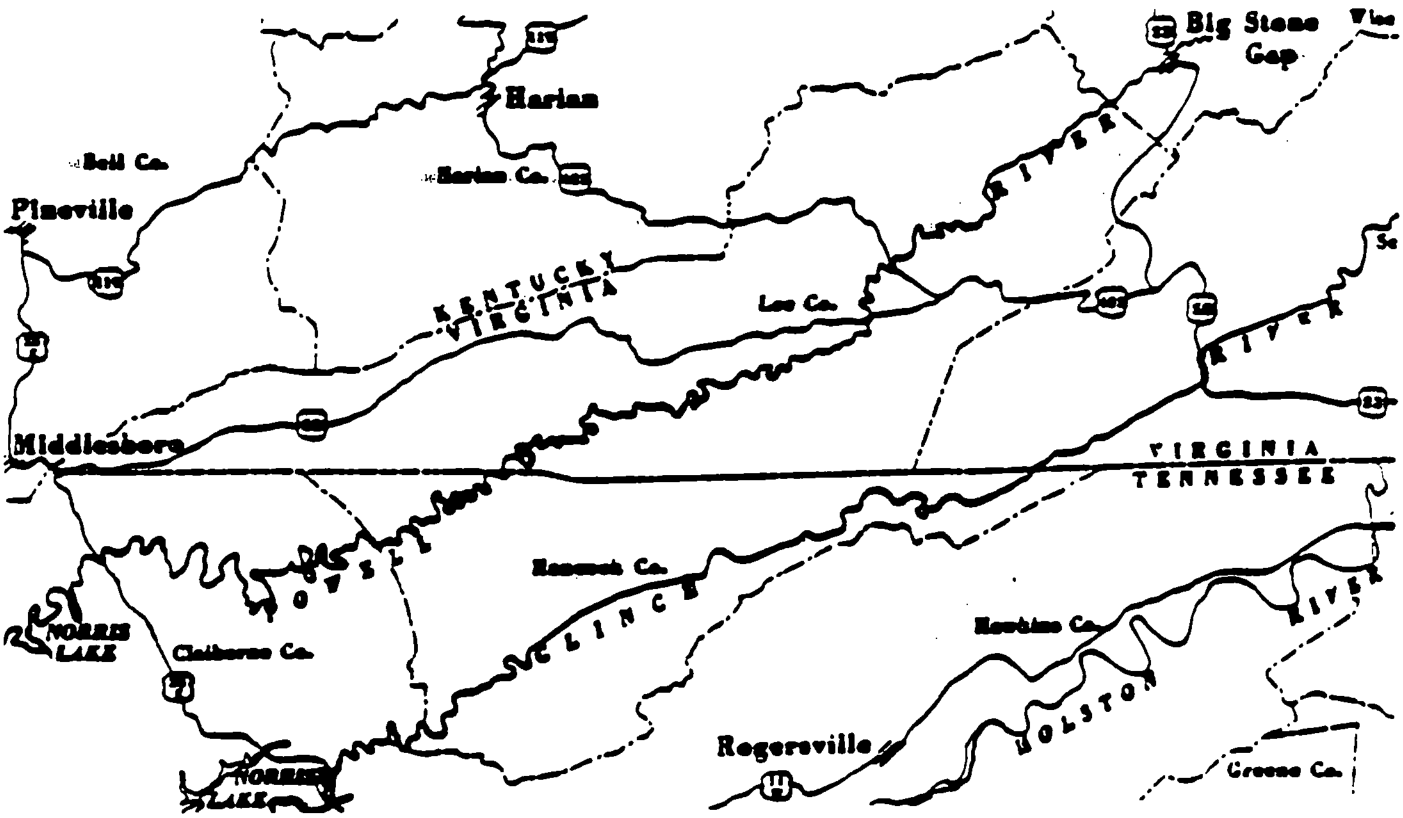
CRITICAL HABITAT



TENNESSEE - Critical Habitat

Hybopsis cahni, "slender chub"

Claiborne and Hancock Counties. Powell River, main channel from backwaters of Norris Lake upstream to the Tennessee-Virginia state line. Clinch River, main channel from backwaters of Norris Lake upstream to the Tennessee-Virginia state line.

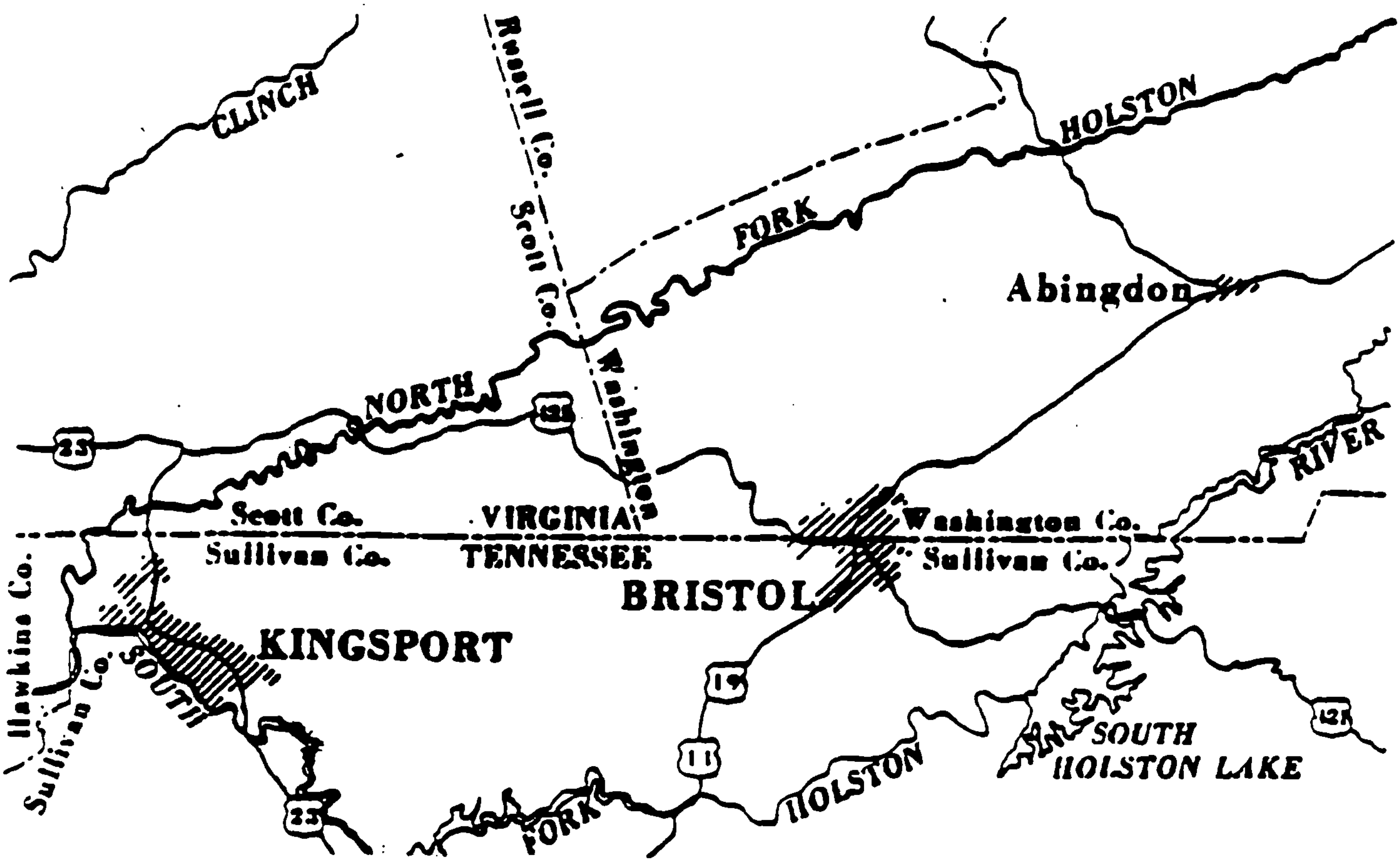


TENNESSEE - Critical Habitat

Hybopsis monacha, "spotfin chub"

Cumberland, Fentress, and Morgan Counties. Emory and Obed Rivers and Clear and Daddy's Creek in Morgan County. Clear Creek in Fentress County. Obed River upstream to U.S. Interstate Highway 40, Clear Creek upstream to U.S. Interstate Highway 40 and Daddy's Creek upstream to U.S. Highway 127 in Cumberland County.

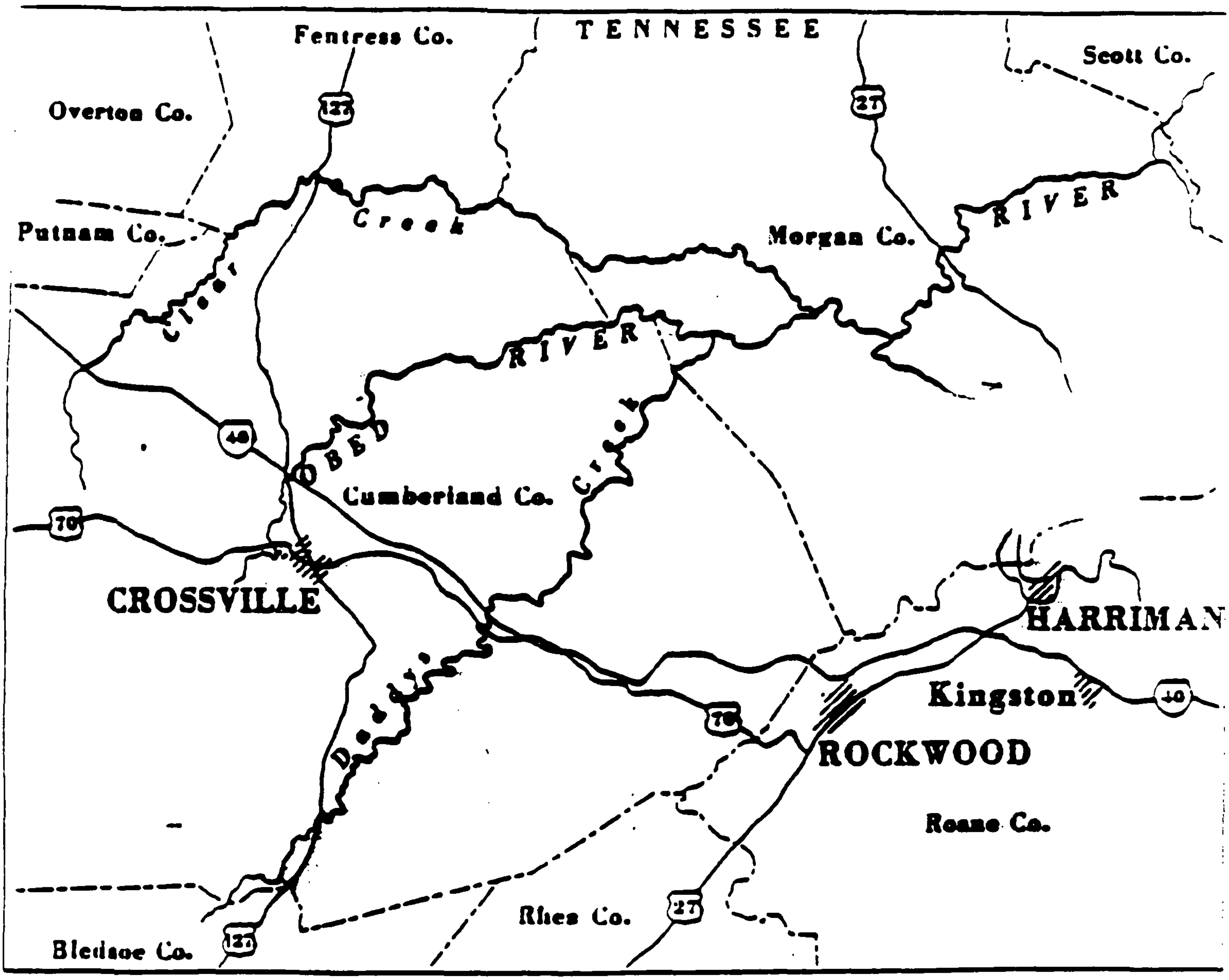
Hawkins and Sullivan Counties. North Fork Holston, main channel upstream from junction with South Fork Holston River to the Tennessee-Virginia state line.



SPOTFIN CHUB

Cumberland, Fentress and Morgan Counties, TENNESSEE

CRITICAL HABITAT



SOURCES OF INFORMATION

There are many sources of information about ground-water conditions in specific parts of the region. At least one agency in each State has cooperated financially with the U.S. Geological Survey, and these agencies have contributed in some way to the results of this report. Further information about reports published or work in progress may be obtained from the district offices of the Geological Survey in each State or from the respective State cooperating agencies.

GPO 888-189

NUS CORPORATION AND SUBSIDIARIES REFERENCE 20 **ELECON NOTE**

REFERENCE # 20

CONTROL NO. F4-8909-62	**DATE:** 9-16-91	**TIME:** 1300
DISTRIBUTION:		
BETWEEN: Walt Williams (Superintendent)	**OF:** City of LaGrange Water Department	**PHONE:** (404) 883-2130
AND: John Jenkins, HALLIBURTON NUS Environmental Corporation JJ 9/16/91		

DISCUSSION:

I called Mr. Williams and asked him where their intake is located. He stated it was northwest of town north of the confluence of Yellowjacket Creek and the Chattahoochee River on the eastern side of Simpson Island. This intake is the sole water source for LaGrange and serves approximately 14,000 connections. The water distribution lines for this system do not go north of Beech Creek. There is an industrial intake (used for an emergency backup supply) approximately 1500 feet upstream of the LaGrange Intake. This intake is owned by Miliken.

He also confirmed that the Chattahoochee River is utilized for both recreational boating and fishing.

NUS CORPORATION AND SUBSIC REFERENCE 19 **TELECON NOTE**

CONTROL NO. F4-8909-62	**DATE:** 9-9-91	**TIME:** 1440
DISTRIBUTION:		
BETWEEN: Tammy Barr	**OF:** City of Franklin Water Department	**PHONE:** (404) 675-3358
AND: John Jenkins, HALLIBURTON NUS Environmental Corporation JJ 9/16/91		

DISCUSSION:

Ms. Barr stated that their only intake is on Centralhatchee Creek (not along pathway). She stated that the first intake used for potable (municipal) water downstream of Atlanta is for the city of LaGrange. There are no systems in Heard County that utilize the Chattahoochee River for potable water. She also stated that the Chattahoochee River is used for recreational boating and fishing.

Stokes, W.R.

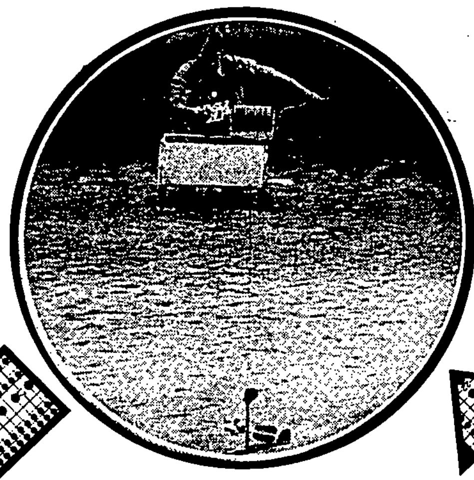
UNITED STATES DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY WATER RESOURCES DIVISION

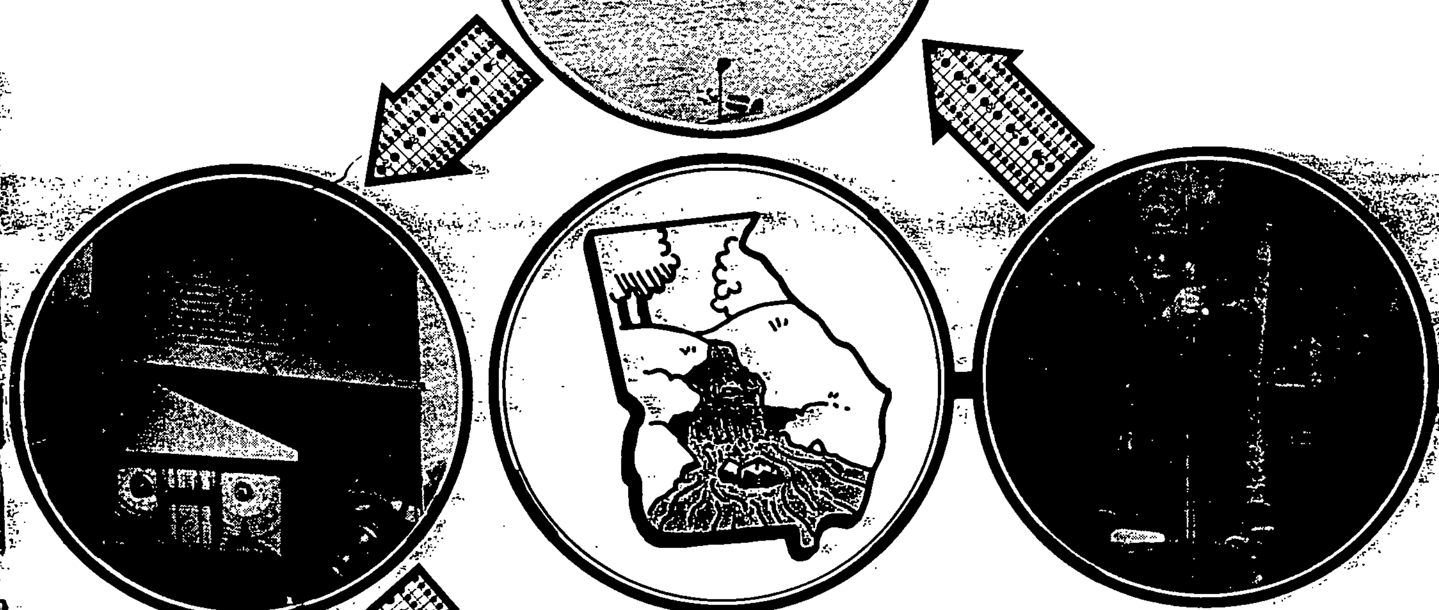
REFERENCE 21

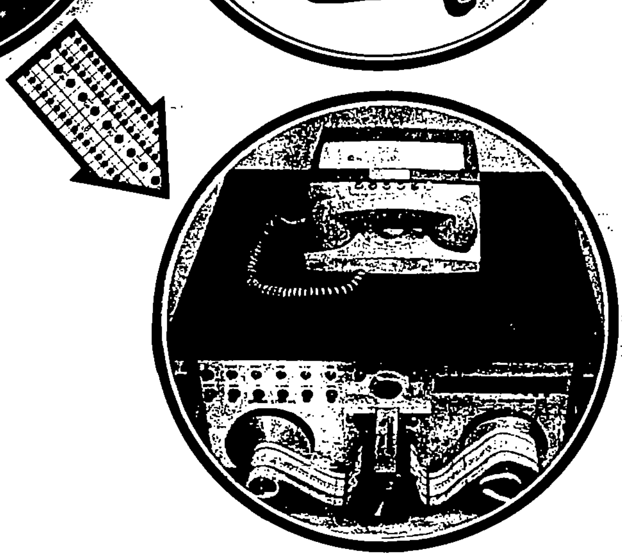
FLOW CHARACTERISTICS of GEORGIA STREAMS

by

Ernest J. Inman







OPEN FILE REPORT

ATLANTA, GEORGIA

1971

FLOW CHARACTERISTICS
OF
GEORGIA STREAMS

Summaries of Flow Duration and of Low and High Flows at Gaging Stations

by

Ernest J. Inman

UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

Open-File Report
Atlanta, Georgia
1971

2-3380. Chattahoochee River near Whitesburg, Ga.

LOCATION.—Lat 33°28'37", long 84°54'04", Carroll County, at downstream end of right bank pier of bridge on State Highway 16, 0.5 mile upstream from Central of Georgia Railroad bridge, 1.2 miles southeast of Whitesburg, 1.5 miles downstream from Cedar Creek, 2.0 miles downstream from Snake Creek, *and at mile 260.*

DRAINAGE AREA.--2,430 sq mi, approximately.

AVERAGE DISCHARGE.--3,843 cfs, unadjusted.

REMARKS.--Flow regulated by Lake Sidney Lanier since January 1956.

DURATION TABLE OF DAILY DISCHARGE FOR YEAR ENDING SEPTEMBER 30

NUMBER OF DAYS IN CLASS

CLASS / YEAR	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	CFS_DAYS
1939					5	21	11	11	30	25	24	20	22	15	46	25	24	20	13	10	12	7	8	3	2	1	5	2	1							1258650.0
1940						10	37	42	25	25	33	34	28	11	44	15	15	13	6	5	2	4	8	1	3	2	1	2								994520.0
1941		1	5	8	5	16	37	13	21	37	46	34	46	26	27	7	10	11	2	4	4	1	1	3												790600.0
1942		17	11		3	13	11	8	13	20	52	21	47	24	26	20	18	13	9	12	9	5	3	1	1	2		2		3		1				1110792.0
1943								7	5	23	40	9	33	20	44	27	49	28	20	11	17	2	4	4	8	2	2	5	2	1	2					1555560.0
1944							1	2	66	49	28	23	25	13	22	15	21	12	20	10	16	5	12	6	7	4	1	3	2	2	1					1433020.0
1945							4	27	33	17	49	32	31	33	26	24	27	17	13	7	8	5	4	1	5			2								1111650.0
1946									19	32	29	18	19	20	25	17	8	21	34	25	25	14	15	9	7	5	7	3	3	4	3		1	1	1	2071530.0
1947					10	6	9	13	16	30	55	27	26	28	29	28	24	18	13	10	6	2	3	2	2	2	1			1	1	3				1181860.0
1948				2	6		5	2	6	16	18	18	47	42	46	23	30	22	15	10	10	7	6	4	8	13	3	4	2	1						1594490.0
1949										16	15	2		10	34	29	27	44	49	33	26	13	14	12	15	4	4	4	1	2	1	2	1	1	1	2270670.0
1950										1	20	23	39	43	62	57	44	30	18	8	9	2	1	4	3	1										1309670.0
1951			5	11	5	6	9	8	4	19	63	30	67	30	24	13	21	17	9	10	8	1	1	2	1											967673.0
1952					12	9	11	14	19	15	53	13	10	15	38	36	26	19	19	10	11	5	6	2	2	3	2	5	3	2	5	1				1526245.0
1953						17	28	24	15	7	25	14	43	16	34	25	23	22	27	11	14	5	8	3	3	2	1	2	3							1314250.0
1966									1	10	41	35	59	35	42	9	26	17	14	13	29	11	8	1	4	3		3	2	1	1					1493370.0
1967										3	15	19	63	32	47	29	40	25	21	24	20	9	5	4	1	4		2	1	1						1525380.0
1968									3	7	7	5	20	27	32	22	64	40	38	25	29	22	10	2	5	5	1	2								1793420.0
1969								1	5	10	22	25	54	38	70	25	26	22	19	13	14	5	3	5	2		3		2		1					1370550.0

CLASS	CFS	CLASS	CFS	CLASS	CFS	CLASS	CFS
0	0.00	9	1400.00	18	4900.0	27	17000
1	465.00	10	1500.00	19	5700.0	28	20000
2	540.00	11	1900.00	20	6500.0	29	23000
3	620.00	12	2100.00	21	7500.0	30	26000
4	710.00	13	2500.0	22	8600.0	31	30000
5	810.00	14	2800.0	23	9800.0	32	34000
6	940.00	15	3300.0	24	11000.0	33	39000
7	1100.00	16	3700.0	25	13000.0	34	45000
8	1200.00	17	4300.0	26	15000.0		

LOWEST MEAN DISCHARGE, IN CFS, AND RANKING, FOR THE FOLLOWING NUMBER OF CONSECUTIVE DAYS IN YEAR ENDING MARCH 31

YEAR	1		3		7		14		30		60		90		120		183		ANNUAL	
1940	880.00	4	913.00	6	936.00	5	943.00	4	1000.00	5	1050.00	3	1140.00	2	1230.00	2	1820.00	5	2820.00	3
1941	920.00	7	920.00	7	956.00	7	970.00	5	997.00	4	1220.00	6	1380.00	7	1710.00	10	1970.00	8	2610.00	1
1942	468.00	1	483.00	1	498.00	1	513.00	1	537.00	1	678.00	1	794.00	1	1060.00	1	1590.00	1	2750.00	2
1943	1060.00	8	1110.00	10	1210.00	11	1380.00	11	1630.00	13	1660.00	12	2060.00	11	2200.00	11	2220.00	11	3760.00	11
1944	1110.00	11	1140.00	11	1150.00	9	1290.00	10	1480.00	9	1650.00	10	1600.00	9	1690.00	8	2140.00	10	3940.00	12
1945	1060.00	9	1090.00	9	1110.00	8	1110.00	7	1130.00	7	1270.00	7	1370.00	6	1480.00	6	1730.00	4	3280.00	5
1946	1060.00	10	1070.00	8	1160.00	10	1190.00	9	1590.00	12	2010.00	13	2280.00	15	2310.00	13	2420.00	12	5270.00	17
1947	1170.00	12	1200.00	12	1280.00	12	1430.00	12	1490.00	10	1580.00	9	1680.00	10	1710.00	9	1960.00	7	3940.00	13
1948	670.00	3	685.00	3	702.00	3	728.00	3	905.00	3	1060.00	4	1240.00	4	1360.00	4	1900.00	6	3580.00	8
1949	1410.00	16	1410.00	14	1480.00	14	1500.00	13	1550.00	11	1810.00	11	2250.00	13	2900.00	17	3300.00	17	5520.00	19
1950	2260.00	19	2260.00	19	2350.00	19	2480.00	19	2590.00	18	3060.00	18	3080.00	18	3230.00	18	3610.00	18	4710.00	16
1951	1350.00	14	1400.00	13	1470.00	13	1500.00	14	1670.00	14	2200.00	15	2270.00	14	2300.00	12	2570.00	14	3070.00	4
1952	600.00	2	605.00	2	608.00	2	650.00	2	736.00	2	1030.00	2	1160.00	3	1300.00	3	1590.00	2	4010.00	14
1953	890.00	5	890.00	4	911.00	4	1020.00	6	1060.00	6	1120.00	5	1250.00	5	1460.00	5	1710.00	3	3410.00	6
1954	890.00	6	890.00	5	940.00	6	1120.00	8	1170.00	8	1340.00	8	1490.00	8	1540.00	7	2000.00	9	3610.00	9
1966	1510.00	17	1660.00	17	1820.00	16	1920.00	16	2010.00	15	2080.00	14	2100.00	12	2340.00	14	2490.00	13	4030.00	15
1967	1390.00	15	1430.00	15	2010.00	17	2060.00	17	2280.00	17	2460.00	16	2590.00	16	2630.00	15	2820.00	15	3750.00	10
1968	1510.00	18	1900.00	18	2040.00	18	2140.00	18	3130.00	19	3300.00	19	3750.00	19	4130.00	19	4740.00	19	5280.00	18
1969	1230.00	13	1610.00	16	1800.00	15	1900.00	15	2070.00	16	2530.00	17	2640.00	17	2800.00	16	2990.00	16	3580.00	7

HIGHEST MEAN DISCHARGE, IN CFS, AND RANKING, FOR THE FOLLOWING NUMBER OF CONSECUTIVE DAYS IN YEAR ENDING SEPTEMBER 30

YEAR	1		3		7		15		30		60		90		120		183		ANNUAL	
1939	20400.0	13	19700.0	12	14300.0	13	10200.0	12	9700.0	6	7640.0	8	6530.0	9	5780.0	11	4890.0	10	3450.0	13
1940	19800.0	14	18000.0	14	12100.0	14	6780.0	16	5120.0	18	4470.0	18	4190.0	18	3920.0	18	3560.0	17	2720.0	17
1941	10500.0	19	10200.0	18	7260.0	19	6350.0	18	4520.0	19	3250.0	19	2830.0	19	2860.0	19	2510.0	19	2170.0	19
1942	30500.0	5	26800.0	5	18100.0	6	12200.0	7	8960.0	8	7270.0	10	5790.0	13	5110.0	14	4340.0	14	3040.0	16
1943	27300.0	8	26300.0	6	18600.0	5	12100.0	8	8650.0	12	7610.0	9	7270.0	6	7130.0	5	5970.0	6	4260.0	5
1944	26000.0	9	24800.0	7	17300.0	9	14100.0	4	11200.0	4	9580.0	4	9030.0	3	7710.0	4	6130.0	5	3920.0	9
1945	18700.0	16	16100.0	15	10600.0	16	7730.0	15	6250.0	15	5020.0	16	5080.0	15	4620.0	15	3950.0	16	3050.0	15
1946	57500.0	1	44900.0	1	30800.0	2	20400.0	1	14900.0	1	12500.0	1	11700.0	1	10900.0	1	8930.0	1	5680.0	2
1947	33000.0	3	31100.0	3	23200.0	3	13700.0	5	8810.0	11	7060.0	12	6260.0	11	5790.0	10	4850.0	11	3240.0	14
1948	23500.0	11	22000.0	9	17400.0	8	12500.0	6	9290.0	7	8920.0	5	7560.0	5	6530.0	8	5950.0	7	4360.0	4
1949	45100.0	2	40900.0	2	32100.0	1	20300.0	2	12700.0	3	10500.0	2	9580.0	2	8740.0	2	8060.0	2	6220.0	1
1950	13500.0	17	12500.0	17	8620.0	17	6740.0	17	5590.0	17	5040.0	15	4690.0	16	4430.0	16	4160.0	15	3590.0	12
1951	12400.0	18	10100.0	19	7690.0	18	6300.0	19	5760.0	16	5010.0	17	4380.0	17	3940.0	17	3410.0	18	2650.0	18
1952	31200.0	4	27800.0	4	20900.0	4	17300.0	3	14700.0	2	9980.0	3	8380.0	4	8030.0	3	6570.0	3	4170.0	7
1953	21000.0	12	20300.0	11	15900.0	10	10000.0	14	7410.0	14	7070.0	11	6390.0	10	6200.0	9	5220.0	9	3600.0	11
1966	27400.0	6	22800.0	8	17600.0	7	11600.0	9	10600.0	5	8080.0	6	7230.0	7	7000.0	6	5720.0	8	4090.0	8
1967	23600.0	10	18800.0	13	14700.0	12	10500.0	11	8280.0	13	6250.0	14	5800.0	12	5500.0	12	4740.0	12	4180.0	6
1968	18900.0	15	15700.0	16	11800.0	15	10100.0	13	8880.0	9	7910.0	7	6960.0	8	6600.0	7	6170.0	4	4900.0	3
1969	27400.0	7	21800.0	10	15800.0	11	11000.0	10	8840.0	10	6850.0	13	5730.0	14	5220.0	13	4500.0	13	3750.0	10

No city found ! press RETURN to try again.

REFERENCE 22

COVERAGE

STATE	COUNTY	STATE NAME	COUNTY NAME
13	45	Georgia	Carroll Co
13	77	Georgia	Coweta Co
13	149	Georgia	Heard Co

CENTER POINT AT STATE : 13 Georgia
COUNTY : 45 Carroll Co

Press RETURN key to continue...

REGION OF THE COUNTRY

Zipcode found: 30170 at a distance of 10.5 Km

STATE	CITY NAME	FIPSCODE	LATITUDE	LONGITUDE
GA	ROOPVILLE	13045	33.4533	85.1350

Press RETURN key to continue ...

CENSUS DATA

ga power plant wansley
LATITUDE 33:24:48 LONGITUDE 85: 1:57 1980 POPULATION

KM	0.00-.400	.400-.810	.810-1.60	1.60-3.20	3.20-4.80	4.80-6.40	SECTOR TOTALS
S 1	0	0	0	0	0	0	0
S 2	0	0	0	0	0	0	0
S 3	0	0	0	0	0	0	0
S 4	0	0	0	0	0	0	0
S 5	0	0	0	0	0	0	0
S 6	0	0	0	0	0	860	860
S 7	0	0	0	0	0	0	0
S 8	0	0	0	0	0	1355	1355
RING TOTALS	0	0	0	0	0	2215	2215

-2 140 -3 247

Press RETURN key to continue ...

STAR STATION

INDEX NUMBER	STATION NAME	LATITUDE DEGREE	LONGITUDE DEGREE	PERIOD OF RECORD	STABILITY CLASSES	DISTANCE (km)
13874	ATLANTA GA	33.6500	84.4333			6 61.41
13871	ANNISTON/CALHOUN AL	33.5833	85.8500			6 78.05
03813	MACON/LEWIS B WILSON	32.7000	83.6500			6151.17
13876	BIRMINGHAM AL	33.5667	86.7500			6160.04
13873	ATHENS/BEN EPPS GA	33.9500	83.3167			5169.45
13895	MONTGOMERY/DANNELLY	32.3000	86.4000			6177.72
13882	CHATTANOOGA/LOVELL T	35.0333	85.2000			6180.63

Press RETURN key to continue ...

U.S. SOIL DATA

STATE : GEORIGA

LATITUDE : 33:24:48 LONGITUDE : 85: 1:57
THE STATION IS INSIDE H.U. 3130002

GROUND WATER ZONE	:	8			
RUNOFF SOIL TYPE	:	2			
EROSION	:	7.7190E-04			CM/MONTH
DEPTH TO GROUND WATER BETWEEN	:	9.1440E+02	AND	4.5720E+03	
FIELD CAPACITY FOR TOP SOIL	:	7.2000E-02			
EFFECTIVE POROSITY BETWEEN	:	1.0000E-02	AND	1.0000E-01	
SEEPAGE TO GROUNDWATER BETWEEN	:	4.6330E+02	AND	9.2660E+02	CM/MONTH
DISTANCE TO DRINKING WELL	:	2.6000E+04			CM

Press RETURN key to continue ...

U.S. CITY

MENU: Geodata Handling Data List procedures

1. Site level retrieval of data (SITERET)
2. Access Census Data (CENSUS)
3. Determine County Coverage (COVERAGE)
4. Geographic Data Management (GEODM)
5. HUCODE/SOIL locator (HUCODE)
6. Convert to Lat/Long (LATLON)
7. Lookup/Examine Star Station Data (STAR)
8. Find US cities (USCITY)
9. Find Soil Survey Status of Counties (SSURVEY)

Enter an option number or a procedure name (in parentheses)
or a command: HELP, HELP option, BACK, CLEAR, EXIT, TUTOR
GEMS> h

```
Enter an option number or a procedure name (in parentheses)
or a command: HELP, HELP option, BACK, CLEAR, EXIT, TUTOR
GEMS> e(help
[ERR-011] Invalid input values or string

Enter an option number or a procedure name (in parentheses)
or a command: HELP, HELP option, BACK, CLEAR, EXIT, TUTOR
GEMS> (help)
[ERR-011] Invalid input values or string

Enter an option number or a procedure name (in parentheses)
or a command: HELP, HELP option, BACK, CLEAR, EXIT, TUTOR
GEMS> (

Enter an option number or a procedure name (in parentheses)
or a command: HELP, HELP option, BACK, CLEAR, EXIT, TUTOR
GEMS> (HELP)
[ERR-011] Invalid input values or string

Enter an option number or a procedure name (in parentheses)
or a command: HELP, HELP option, BACK, CLEAR, EXIT, TUTOR
GEMS> 566
[ERR-012] Invalid option number input

Enter an option number or a procedure name (in parentheses)
or a command: HELP, HELP option, BACK, CLEAR, EXIT, TUTOR
GEMS>

Enter an option number or a procedure name (in parentheses)
or a command: HELP, HELP option, BACK, CLEAR, EXIT, TUTOR
GEMS>

Enter an option number or a procedure name (in parentheses)
or a command: HELP, HELP option, BACK, CLEAR, EXIT, TUTOR
GEMS> EXIT

Type YES to confirm the EXIT command; type NO to restart GEMS
GEMS> YES
$
$ LOGOUT
 WRT           logged out at 23-AUG-1991 13:01:48.09
 Itemized resource charges, for this session, follow:

NODE: VAXTM1
ACCT: NTIS                              START TIME:    23-AUG-1991 12:58:00.23
PROJ: NTISNUCN                          FINISH TIME:   23-AUG-1991 13:01:48.09
USER: WRT                               BILLING PERIOD:910801
UIC:  [000750,000112]                   WEEKDAY:       FRIDAY
BAUD:                                   TERMINAL PORT: VTA833

DESCRIPTION OF CHARGE                    QUANTITY                EXPENDITURE
---------------------------------------------------------------------------

  ALL CHARGE LEVELS
    300  baud          (Seconds)            228                      0.0000
    CPU TIME           (Seconds)              8                      0.4444
                                                                -----------
    TOTAL FOR THIS SESSION                                     $     0.4444

** Note:  This total reflects the charges for this process only,
```

```
        subprocesses created during this session are accounted for
        separately
Enter selection:PRINT

Connected.
```

GEORGIA DEPARTMENT OF NATURAL RESOURCES
Freshwater Wetlands & Heritage Inventory
Database - July, 1990

For HEARD COUNTY

Scientific Name; Common Name	Last Observed	Precision	Global Rank	State Rank	County; Quad
NOTROPIS CALLITAENIA BLUESTRIPE SHINER	1959-07-30	G	G2	S1	GAHEAR FRANKLIN
HELIANTHUS LONGIFOLIUS LONGLEAF SUNFLOWER	1985-08-31	S	G?	S1	GAHEAR GLENN
HELIANTHUS LONGIFOLIUS LONGLEAF SUNFLOWER	1985-08-31	SC	G?	S1	GAHEAR FROLONA
HELIANTHUS LONGIFOLIUS LONGLEAF SUNFLOWER	1985-08-31	SC	G?	S1	GAHEAR GLENN
HELIANTHUS LONGIFOLIUS LONGLEAF SUNFLOWER	1985-08-31	S	G?	S1	GAHEAR FROLONA
HELIANTHUS LONGIFOLIUS LONGLEAF SUNFLOWER	1985-08-31	SC	G?	S1	GAHEAR FROLONA
HELIANTHUS LONGIFOLIUS LONGLEAF SUNFLOWER	1988-09-17	SC	G?	S2	GAHEAR GLENN
WALDSTEINIA LOBATA PIEDMONT BARREN STRAWBERRY	1990-01-13	SC	G2?	S2	GAHEAR FROLONA
WALDSTEINIA LOBATA PIEDMONT BARREN STRAWBERRY	1990-01-13	SC	G2?	S2	GAHEAR FROLONA
AMPHIANTHUS PUSILLUS POOL SPRITE,SNORKELWORT	1986-03-14	SC	G2	S2	GAHEAR GLENN

REFERENCE 23

GEORGIA DEPARTMENT OF NATURAL RESOURCES
Freshwater Wetlands & Heritage Inventory
Database - July, 1990

For HEARD COUNTY

Scientific Name; Common Name	Last Observed	Precision	Global Rank	State Rank	County; Quad
AMPHIANTHUS PUSILLUS POOL SPRITE,SNORKELWORT	1990-01-13	SC	G2	S2	GAHEAR GLENN,FROLONA
AMPHIANTHUS PUSILLUS POOL SPRITE,SNORKELWORT	1979-12-07	M	G2	S2	GAHEAR GLENN
AMPHIANTHUS PUSILLUS POOL SPRITE,SNORKELWORT	1984-05-17	S	G2	S2	GAHEAR FROLONA
AMPHIANTHUS PUSILLUS POOL SPRITE,SNORKELWORT	1979-11-29	SC	G2	S2	GAHEAR FROLONA
AMPHIANTHUS PUSILLUS POOL SPRITE,SNORKELWORT	1979-12-07	SC	G2	S2	GAHEAR FROLONA
ISOETES MELANOSPORA BLACK-SPORED QUILLWORT	1980-00-00	M	G1	S1	GAHEAR GLENN
ISOETES MELANOSPORA BLACK-SPORED QUILLWORT	1990-01-13	SC	G1	S1	GAHEAR GLENN

GEORGIA DEPARTMENT OF NATURAL RESOURCES
Freshwater Wetlands & Heritage Inventory
Georgia's Protected Animals
(Edition of July 3, 1990)

Scientific Name (Common Name)	Federal Status	State Status
Acipenser brevirostrum (Shortnose Sturgeon)	E	E
Alligator mississippiensis (American Alligator)	T	
Balaena glacialis (Black Right Whale)	E	E
Balaenoptera borealis (Sei Whale)	E	
Balaenoptera physalus (Finback Whale)	E	
Campephilus principalis (Ivory-billed Woodpecker)	E	E
Canis rufus (Red Wolf)	E	
Caretta caretta (Loggerhead Sea Turtle)	T	
Charadrius melodus (Piping Plover)	T	
Chelonia mydas (Green Turtle)	T	
Dendroica kirtlandii (Kirtland's Warbler)	E	E
Dermochelys coriacea (Leatherback Turtle)	E	E
Drymarchon corais couperi (Eastern Indigo Snake)	T	T
Eretmochelys imbricata (Hawksbill Turtle)	E	E
Falco peregrinus anatum (American Peregrine Falcon)	E	E
Falco peregrinus tundrius (Arctic Peregrine Falcon)	T	
Felis concolor coryi (Florica Panther)	E	
Felis concolor cougar (Eastern cougar)	E	E
Geomys pinetis fontenalus (Sherman's Pocket Gopher)		E
Haideotriton wallacei (Georgia's Blind Cave Salamander)		U
Haliaeetus leucocephalus (Southern Bald Eagle)	E	E
Hybopsis monacha (Spotfin Chub)	T	
Lepidochelys kempi (Atlantic Ridley Turtle)	E	E
Megaptera novaeangliae (Humpback Whale)	E	E
Mycteria americana (Wood Stork)	E	
Myotis grisescens (Gray Bat)	E	E
Myotis sodalis (Indiana Bat)	E	E
Noturus flavipinnis (Yellowfin Madtom)	T	
Pelecanus occidentalis (Eastern Brown Pelican)		E
Percina antesella (Amber Darter)	E	
Percina jenkinsi (Conasauga Logperch)	E	
Percina tanasi (Snail Darter)	T	
Physeter macrocephalus (Sperm Whale)	E	
Picoides borealis (Red-cockaded Woodpecker)	E	E
Trichechus manatus (West Indian Manatee)	E	E
Typhlichthys subterraneus (Southern Cave Fish)		E
Vermivora bachmanii (Bachman's Warbler)	E	E

GEORGIA DEPARTMENT OF NATURAL RESOURCES
Freshwater Wetlands & Heritage Inventory
Georgia's Protected Plants
(Edition of July 3, 1990)

Scientific Name (Common Name)			Federal Status	State Status
Amphianthus pusillus	(Pool Sprite, Snorkelwort)	02/05/88	T	E
Arabis georgiana	(Georgia Rockcress)	/ /		T
Asplenium heteroresiliens	(Wagner Spleenwort)	/ /		T
Baptisia arachnifera	(Hairy Rattleweed)	04/26/78	E	E
Bumelia thornei	(Buckthorn)	/ /		E
Cacalia diversifolia	(Variable-leaf Indian Plantain)	/ /		T
Calamintha ashei	(Ashe Savory)	/ /		T
Carex amplisquama	(Sedge)	/ /		T
Carex biltmoreana	(Biltmore Sedge)	/ /		T
Carex misera	(Sedge)	/ /		T
Carex purpurifera	(Purple Sedge)	/ /		T
Croomia pauciflora	(Croomia)	/ /		T
Cuscuta harperi	(Harper Dodder)	/ /		T
Cypripedium acaule	(Pink Ladyslipper)	/ /		U
Cypripedium calceolus	(Yellow Ladyslipper)	/ /		U
Draba aprica	(Open-ground Whitlow-grass)	/ /		E
Echinacea laevigata	(Smooth Coneflower)	/ /		T
Elliottia racemosa	(Georgia Plume)	/ /		E
Fimbristylis perpusilla	(Harper Fimbristylis)	/ /		E
Fothergilla gardenii	(Dwarf Witch-alder)	/ /		T
Hartwrightia floridana	(Hartwrightia)	/ /		T
Helonias bullata	(Swamp Pink)	/ /	T	
Hydrastis canadensis	(Golden Seal)	/ /		E
Hymenocallis coronaria	(Shoals Spiderlily)	/ /		E
Isoetes melanospora	(Black-spored Quillwort)	02/05/88	E	T
Isoetes tegetiformans	(Mat-forming Quillwort)	02/05/88	E	
Isotria medeoloides	(Small Whorled Pogonia)	09/09/88	E	
Jeffersonia diphylla	(Twinleaf)	/ /		E
Leavenworthia exigua var exigua	(Glade-cress)	/ /		T
Lindera melissifolia	(Pondberry)	07/31/86	E	
Lindernia saxicola	(False Pimpernel)	/ /		E
Litsea aestivalis	(Pondspice)	/ /		T
Lythrum curtissii	(Curtiss Loosestrife)	/ /		E
Marshallia mohrii	(Mohr Barbara Buttons)	09/07/88	T	
Myriophyllum laxum	(Piedmont Water-milfoil)	/ /		T
Nestronia umbellula	(Indian Olive)	/ /		T
Oxypolis canbyi	(Canby Dropwort)	02/25/86	E	T
Panicum hirstii	(Hirst Panic Grass)	/ /		E
Physostegia veroniciformis	(False-tooth Cinquefoil)	/ /		T
Potentilla tridentata	(Three-tooth Cinquefoil)	/ /		E
Ptilimnium nodosum	(Piedmont Bishop-weed, Harperella)	09/28/88	E	
Quercus oglethorpensis	(Oglethorpe Oak)	/ /		T
Rhododendron prunifolium	(Plumleaf Azalea)	/ /		T
Rhus michauxii	(False Poison (Michaux) Sumac)	09/28/89	E	
Sagittaria secundifolia	(Kral Water-plantain)	04/13/90	T	
Salix floridana	(Florida Willow)	/ /		E

GEORGIA DEPARTMENT OF NATURAL RESOURCES
Freshwater Wetlands & Heritage Inventory
Georgia's Protected Plants
(Edition of July 3, 1990)

Scientific Name (Common Name)		Federal Status	State Status
Sarracenia flava (Yellow Flytrap)	/ /		T
Sarracenia leucophylla (Whitetop Pitcherplant)	/ /		T
Sarracenia minor (Hooded Pitcherplant)	/ /		T
Sarracenia oreophila (Green Pitcherplant)	09/21/79	E	
Sarracenia psittacina (Parrot Pitcherplant)	/ /		T
Sarracenia purpurea (Purple Pitcherplant)	/ /		E
Sarracenia rubra (Sweet Pitcherplant)	/ /		E
Schisandra glabra (Bay Starvine)	/ /		T
Schizachyrium niveum (Bluestem)	/ /		T
Scutellaria montana (Large-flower Skullcap)	06/20/86	E	T
Sedum pusillum (Granite Rock Stonecrop)	/ /		T
Senecio millefolium (Piedmont Ragwort)	/ /		T
Shortia galacifolia (Oconee-bells)	/ /		E
Silene polypetala (Fringed Campion)	/ /		E
Spiraea virginiana (Virginia Spirea)	06/15/90	T	
Thalictrum cooleyi (Cooley Meadowrue)	02/07/89	E	
Thalictrum debile (Southern Meadowrue)	/ /		T
Torreya taxifolia (Florida Torreya)	01/23/84	E	E
Trientalis borealis (Northern Starflower)	/ /		E
Trillium persistens (Persistent Trillium)	04/26/78	E	E
Trillium reliquum (Relict Trillium)	04/04/88	E	
Trillium woodii (Woods False Hellebore, Ozark Bunchflr.	/ /		E
Viburnum bracteatum (Limerock Arrowwood)	/ /		E
Waldsteinia lobata (Piedmont Barren Strawberry)	/ /		T

United States
Environmental Protection
Agency

REFERENCE 24

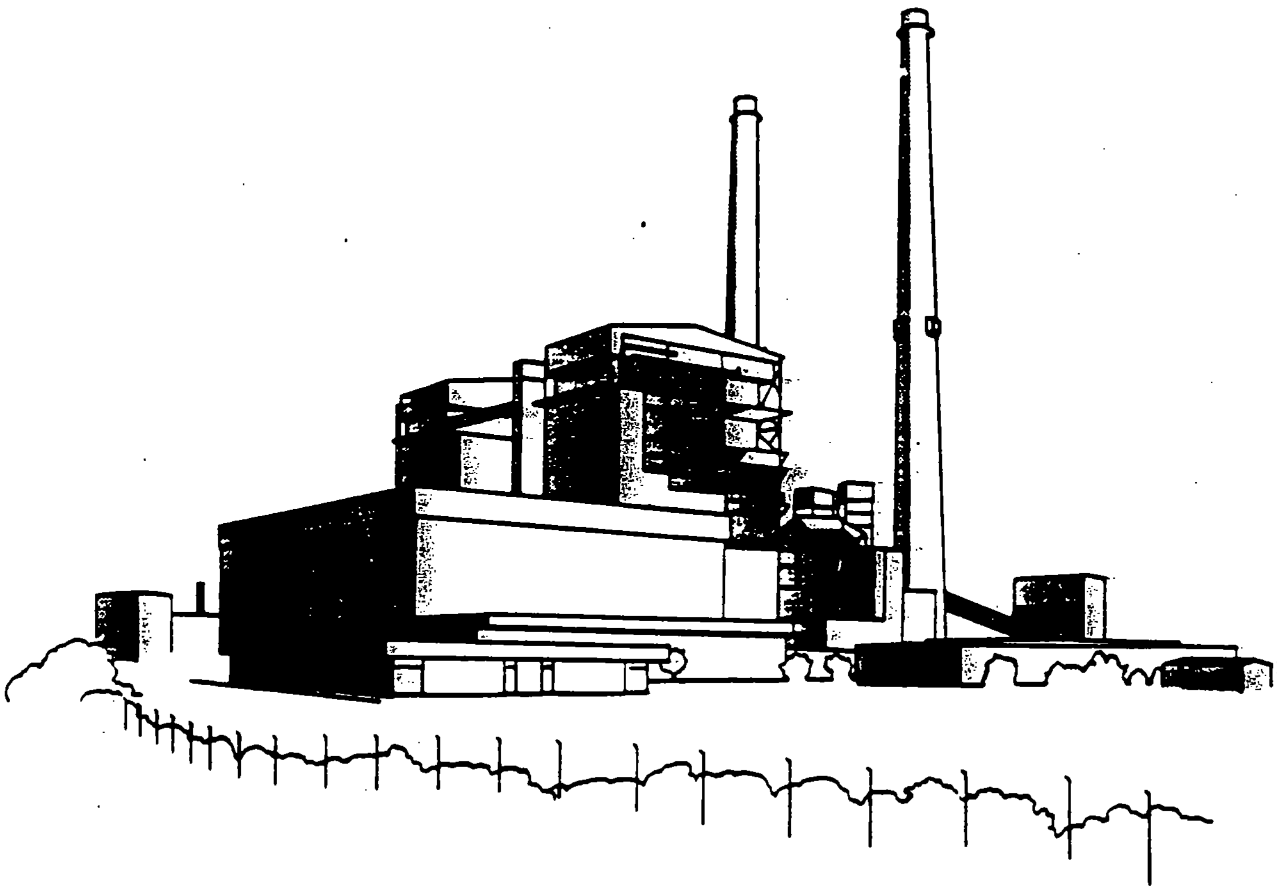
A/530-SW-88-002
bruary 1988

Solid Waste

EPA

Report to Congress

Wastes from the Combustion of Coal by Electric Utility Power Plants



permeability of bottom ash is usually slightly higher. Boiler slag is higher still, having a permeability comparable to that of fine gravel.

Shear strength is an important determinant of the shape and structural stability of wastes disposed in landfills; a strong material (i.e., one with high shear strength) can form steep slopes and support heavy loads from above. Two indicators of shear strength are cohesion, a measure of the attraction between particles due to electrostatic forces, and the angle of internal friction, an indicator of the friction between particles. Dry, nonalkaline ash has no cohesion. Dry ash that is alkaline demonstrates some cohesion and, when compacted, increases in strength over time. The angle of internal friction associated with ash varies with the degree of compaction, although it is similar to that for clean, graded sand.

3.2.1.5 Chemical Characteristics of Ash

The chemical composition of ash is a function of the type of coal that is burned, the extent to which the coal is prepared before it is burned, and the operating conditions of the boiler. These factors are very plant- and coal-specific.

In general, over 95 percent of ash is made up of silicon, aluminum, iron, and calcium in their oxide forms. Magnesium, potassium, sodium, and titanium are also present to a lesser degree. Exhibit 3-5 shows the concentration of these major elements typically found in fly ash, bottom ash, and boiler slag.

Ash also contains many other elements in much smaller quantities. The types and proportions of these trace elements are highly variable and not

EXHIBIT 3-5

LOW AND HIGH CONCENTRATIONS OF MAJOR CHEMICAL CONSTITUENTS FOUND IN ASH GENERATED BY COAL-FIRED POWER PLANTS (parts per million)

	Fly Ash		Bottom Ash/Boiler Slag	
	Low	High	Low	High
Aluminum	11,500	144,000	88,000	135,000
Calcium	5,400	177,100	8,400	50,600
Iron	7,800	289,000	27,000	203,000
Magnesium	4,900	60,800	4,500	32,500
Potassium	1,534	34,700	7,300	15,800
Silicon	196,000	271,000	180,000	273,000
Sodium	1,180	20,300	1,800	13,100
Titanium	400	15,900	3,300	7,210

Source: Utility Solid Waste Activities Group, Report and Technical Stuc on the Disposal and Utilization of Fossil-Fuel Combustion By-Products, Appendix A, Submitted to the U.S. Environmental Protection Agency, October 26, 1982, p. 31.

readily categorized. Concentrations for various trace elements in coal ash are shown in Exhibit 3-6, which indicates the potential range of values and median concentration for such trace elements for coals from different regions of the U.S. A summary of how the concentration of elements in ash varies according to coal source is shown in Exhibit 3-7. For example, Eastern and Midwestern coal ashes usually contain greater amounts of arsenic, selenium, chromium, and vanadium than do Western coal ashes, while Western coals have larger proportions of barium and strontium. Coal mining and cleaning techniques can reduce the amount of trace elements that are ultimately found in the ash after combustion. For example, in some cases, coal cleaning can remove more than half of the sulfur, arsenic, lead, manganese, mercury, and selenium that is contained in the coal prior to combustion.

The proportions of elements contained in fly ash, bottom ash, and boiler slag can vary. Exhibit 3-8 provides ranges and median values for element concentrations in different types of ash -- bottom ash and/or boiler slag, and fly ash. The concentrations of elements formed in fly ash are shown for two types -- the larger particles removed from the flue gas by mechanical collection and the smaller particles removed with an electrostatic precipitator or a baghouse (see Section 3.2.1.2 for more detail on methods of ash collection). For example, much higher quantities of arsenic, copper, and selenium are found in fly ash than are found in bottom ash or boiler slag. The distribution of elements among the different types of ash is largely determined by the firing temperature of the boiler relative to the coal's ash fusion temperature, which in turn affects the proportions of volatile elements that end up in fly ash and bottom ash. Some elements, such as sulfur, mercury, and chlorine, are almost completely volatilized and leave the boiler

EXHIBIT 3-6

ELEMENT CONCENTRATIONS IN ASH FROM THREE GEOGRAPHIC SOURCES
(milligrams per kilogram)*

Element	Eastern Coal		Midwestern Coal		Western Coal	
	Range	Median	Range	Median	Range	Median
Arsenic	2.0-279	75	0.50-179	54	1.3-129	18
Barium	52-2200	892	300-4300	905	300-5789	2700
Boron	10.0-580	121	10-1300	870	41.9-1040	311
Cadmium	0.10-8.24	1.59	0.50-18	2.6	0.10-14.3	1.01
Chromium	34-437	165	70-395	172	3.4-265	45
Cobalt	6.22-79	40.6	19-70	35.7	4.9-69	13.0
Copper	3.7-349	136	20-330	125	29-340	74.8
Fluorine	0.40-89	8.8	3.2-300	75	0.40-320	50.1
Lead	1.3-222	18.0	3.0-252	149	0.40-250	26.1
Manganese	79-430	190	194-700	410	56.7-769	194
Mercury	0.02-4.2	0.192	0.005-0.30	0.044	0.005-2.5	0.067
Molybdenum	0.84-51	15.0	7.0-70	43	1.4-100	12.0
Nickel	6.6-258	78	26-253	121	1.8-229	38.0
Selenium	0.36-19.0	8.05	0.08-19	7.0	0.13-19.0	4.1
Silver	0.25-8.0	0.695	0.10-1.20	0.39	0.040-6.0	0.26
Strontium	59-2901	801	30-2240	423	931-3855	2300
Thallium	7.0-28.0	25.0	2.0-42	16.0	0.10-3.50	1.06
Vanadium	110-551	269	100-570	270	11.9-340	94
Zinc	16-1420	163	20-2300	600	4.0-854	71

* Values shown are for all types of ash combined.

Source: Tetra Tech Inc., Physical-Chemical Characteristics of Utility Solid Wastes. EPRI EA-3236, September 1983.

EXHIBIT 3-7

EFFECT OF GEOGRAPHIC COAL SOURCE ON ASH ELEMENT CONCENTRATION

Element	Concentration Pattern
Arsenic	low in western coal ash; eastern and midwestern coal ashes indistinguishable
Barium	highest in western coal ash
Cadmium	most concentrated in midwestern coal ash
Chromium	low in western coal ash; eastern and midwestern coal ashes indistinguishable
Mercury	highest in eastern coal ash; all distributions highly skewed toward high concentrations
Lead	highest in midwestern coal ash
Selenium	similar in eastern and midwestern coal ash; lower in western coal ash
Strontium	greater in eastern than in midwestern coal ash; greater still in western coal ash
Vanadium	similar in eastern and midwestern coal ash; lower in western coal ash
Zinc	greater in eastern than in western coal ash; greater still in midwestern coal ash

Source: Tetra Tech, Inc., Physical-Chemical Characteristics of Utility Solid Wastes, EPRI EA-3236, September 1983, p. 3-30.

EXHIBIT 3-8

ELEMENT CONCENTRATIONS IN THREE TYPES OF ASH
(milligrams per kilogram)

			Fly Ash			
	Bottom Ash/Boiler Slag		Mechanical Hopper Ash		Fine Fly Ash	
Element	Range	Median	Range	Median	Range	Median
Silver	0.1-.51	0.20	0.08-4.0	0.70	0.04-8.0	0.501
Arsenic	.50-168	4.45	3.3-160	25.2	2.3-279	56.7
Boron	41.9-513	161	205-714	258	10.0-1300	371
Barium	300-5789	1600	52-1152	872	110-5400	991
Cadmium	0.1-4.7	0.86	0.40-14.3	4.27	0.10-18.0	1.60
Cobalt	7.1-60.4	24	6.22-76.9	48.3	4.90-79.0	35.9
Chromium	3.4-350	120	83.3-305	172	3.6-437	136
Copper	3.7-250	68.1	42.0-326	130	33.0-349	116
Fluorine	2.5-104	50.0	2.50-83.3	41.8	0.40-320	29.0
Mercury	0.005-4.2	0.023	0.008-3.00	0.073	0.005-2.50	0.10
Manganese	56.7-769	297	123-430	191	24.5-750	250
Lead	0.4-90.6	7.1	5.2-101	13.0	3.10-252	66.5
Selenium	.08-14	0.601	0.13-11.8	5.52	0.60-19.0	9.97
Strontium	170-1800	800	396-2430	931	30.0-3855	775
Vanadium	12.0-377	141	100-377	251	11.9-570	248
Zinc	4.0-798	99.6	56.7-215	155	14.0-2300	210

Source: Tetra Tech, Inc., Physical-Chemical Characteristics of Utility Solid Wastes, EPRI EA-3236, September 1983, p. 3-24.